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ON THE FORM, GROWTH, AND CONSTRUCTION OF SHELLS.

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(*With Two Plates, one Coloured and one Plain.*)

SHELLS are often called the "habitations" of fishes, or of marine animals, or snails. Every one has seen the device of a snail, with the motto, "always at home," on juvenile letters. The quarrymen of the Cotteswolde Hills go so far as to call some fossils "snail-houses," the same epithet which they apply to empty shells of the common garden snail. The term is not quite correct, for they are more properly *skeletons*, and we do not "inhabit" our bones, though Byron calls the *skull* a "tenement," and "the palace of the soul." Nevertheless, the expression is sufficiently indicative of the sense in which it is popularly used, and may pass muster without any further challenge on our part.

One afternoon last summer we visited the fish-house of the Zoological Gardens, and paused to watch the manœuvres of a hermit crab housed in a whelk-shell. Just then a lady of distinguished appearance called the attention of her friends to the same truculent animal, and expressed her lively satisfaction at having thus become acquainted with *the creature which made that kind of shell!*

We hope before long to introduce our readers to a better acquaintance with the original fabricator of that common object of the shore, and to show how the forms and patterns of shells are suited to the wants and welfare of their proper owners. But at present we intend to look more especially at certain specimens put together to illustrate the structure of shells in general, and to show their architectural rather than their physiological peculiarities.

It may be seen at a glance that many shells are *bivalve*, like the oyster and cockle (see Coloured Plate, Fig. 12, *Isocardia*); while a few, called "Chitons" (see Coloured Plate, Fig. 14, *Chiton squamosus*, and Woodcut (1) of *Chiton piceus*) are *multivalve*; but the great majority are *univalve* (see same Plate, Figs. 1—10), and sometimes tent-shaped (Fig. 6, *Patella*), or tubular (Fig. 13, *Aspergillum*; Fig. 8, *Dentalium*; Fig. 9, *Vermetus*; Fig. 10, *Siliquaria*), but for the most part spiral (Figs. 2, 3, 4, 7, 9, and 10), though exhibiting an endless diversity in their proportions, as well as in their sculpturing and colour.

Fig. 1, *Chiton piceus*, (side view).

All insects, crabs, and other articulate animals are symmetrical, having the organs in pairs, *i.e.*, the right side like the left. In corals and star-fishes the bilaterality is usually disguised by a radiate arrangement of the parts. But in snails the symmetry of the eyes, tentacles, and other organs of the head, is lost in the body of the creature. Instead of a double heart, and two series of gills, these organs are single, and placed on one side. When on the left side, the growth is from left to right, to provide space; but in shells which are symmetrical, like the pearly nautilus, the keyhole limpet, and the *Ampullaria*, the gills are developed symmetrically on each side, or nearly so.

The tendency to grow in a *spiral form* is very characteristic of the class Mollusca. Some writers have accounted for it in a very matter-of-fact way. "Molluscous animals are long and worm-like; therefore Nature has coiled them up, that their tails may not be an incumbrance to them."

It is easily ascertained that the snail has a small spiral shell when it first quits the egg, and the young whelk may be examined while still a prisoner in the same capsule with its brothers and sisters.

The convenience of the arrangement is obvious, and that may be sufficient for us at present, but the time is coming when naturalists will desire to look more closely into these things.

How happens it that the embryo-snail coiling itself up closely in its narrow cell, almost always takes a direction from left to right, following the course of the sun, and forming a dextral spiral, or *right-handed* shell, like an ordinary screw? Such a course is not absolutely necessary, neither is it accidental. A few whelks and garden-snails—perhaps one in ten thousand—are *left-handed*; and certain kinds of whelks and land-snails (see Coloured Plate, Fig. 2) are as frequently reversed

as right. The greater part of the genus *Clausilia* (numbering upwards of two hundred species) is reversed. The species of the genera *Physa* and *Triforis* appear to be all reversed. All the specimens of *Fusus contrarius*, Sby., so abundant in the Red Crag, and also found living in Vigo Bay, on the coast of Spain, are left-handed. But, after all, these latter are the exceptions. Every one familiar with garden plants will have noticed that the hop turns round its pole in one direction, going to meet the light, while the scarlet-runner takes an opposite course, as invariably as the sun it follows.*

The tendency to *spirality* is observable in bivalve shells, especially in *Isocardia*, whose separate valves resemble two spiral univalves—one right-handed, the other left-handed (see Coloured Plate, Fig. 12), with small spires and large apertures.

In this shell, as in the common cockle, one valve is placed on each side of the shell-fish, which is usually symmetrical, and lives in a vertical position as regards the plane of its valves.

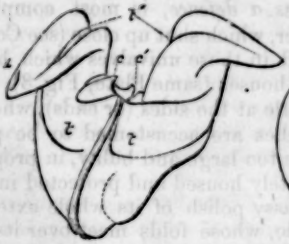


FIG. 2. FIG. 3.

FIG. 2 represents the internal cast of *Diceras arietinum*, Lamk. Coral Rag, France, $\frac{1}{4}$ nat. size, *a*, point of attachment; *c,c,c'*, casts of dental pits; *t,t,t, t', t'*, furrows produced by muscular ridges.

Fig. 3, internal cast of *Requienia Lonsdalei*, Sby. sp., $\frac{1}{2}$ nat. size, Lower Greensand, Bowood, Wilts. From *Quart. Journ. Geol. Soc.*, 1855, Vol. XI. p. 53, Figs. 28 and 29.

To this there are some exceptions; for example, the oyster and scallop, which, like the turbot and sole among fishes, lie, the former on its left side, and the latter on its right side, and fatten at their ease.

The valves of the cockle are united by an elastic ligament, and articulated by projecting teeth, which form a very complete hinge. It is obvious that the valves of a shell cannot grow so freely along the hinge, as on the rest of the margin, but it may shoot out to a great length, as in the "razor-shell" (*Solen*), or in three directions, as in the "hammer-oyster"

* Unluckily the botanists have chosen to reverse the terms employed in mechanics, and call the spiral of the hop right-handed.

(*Malleus*), while in the "heart-cockle" each valve takes a spiral (see Coloured Plate, Fig. 12).

There are some fossil shells called *Diceras*, in which the two valves resemble horns, and others called *Requienia* (see Woodcut, Figs. 2 and 3), with one valve produced into a horn. In *Chama* the *umbones* are also spiral.

In many bivalves the beaks are turned *forwards*, towards the head of the animal (*not always*, as stated in some big books). But the oyster is again an exception in this respect; and if among the exotic or fossil species you find some with spiral growth, the spiral is turned *backwards*; indeed, the number of exceptions is so great, that one fears to make any general assertion. *Anomia*, when it grows inside other shells, may have its umbo a little removed from the margin, and the fossil genera of *Hippurites* exhibit every condition between a marginal ligament and a spiral beak, like *Chama*, and a patelliform valve, with a ligament wholly internal, and a central umbo.

The shell, considered *as a defence*, is most complete in those bivalves, like the oyster, which shut up close (see Coloured Plate, Figs. 11 and 12), and in those univalves which have an *operculum*, or door, to their houses (same Plate, Fig. 3).

Many *bivalves* gape a little at the sides (or ends), where the foot and the respiratory tubes are accustomed to be pushed out; and many *univalves* are too large and bulky, in proportion to their shells, to be completely housed and protected in them.

The cowry owes the glassy polish of its whole exterior to the amplitude of its mantle, whose folds meet over its back, and ordinarily conceal the shell entirely.

In the shining Marginellas and Olives, and some Volutes, the shell is partially glazed by the same envelope.

One sort of garden-slug, the *Testacella* (see Woodcut,

FIG. 4. *Testacella haliotidea*, side view; *s*, shell; *b*, end view of a specimen which has been disturbed from its winter sleep, showing the mantle partly expanded round the shell.

Fig. 4), has a small, shield-like shell on its tail, while the rest appear to have no shell at all, it being always rudimentary, and usually internal. Such is also the case in *Aplysia*, the "sea-hare," in which the shell is entirely concealed by the mantle. On the other hand, *Cyclostoma elegans* (see Woodcut, Fig. 6), a snail found in hedgerows and thickets of the chalk districts, covers the aperture of its shell with a close-fitting, shelly plate,

Fig. 1. Operculum of Turbo fluctuatus; *a*, outside.

Fig. 2. Operculum of Imperator olivaceus; *b*, outside; *c*, inside.

Fig. 5. Conus tesselatus, transverse section.

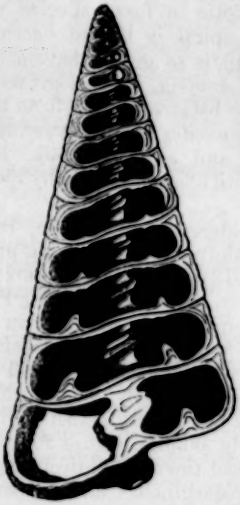


Fig. 8. Cerithium telescopium, longitudinal section.

Fig. 4. Conus tesselatus, longitudinal section.

Fig. 6. Marginella glabella, longitudinal section.

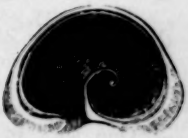


Fig. 7. Cypræa Turdus, transverse section.

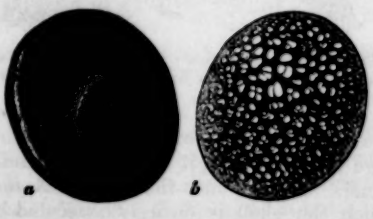
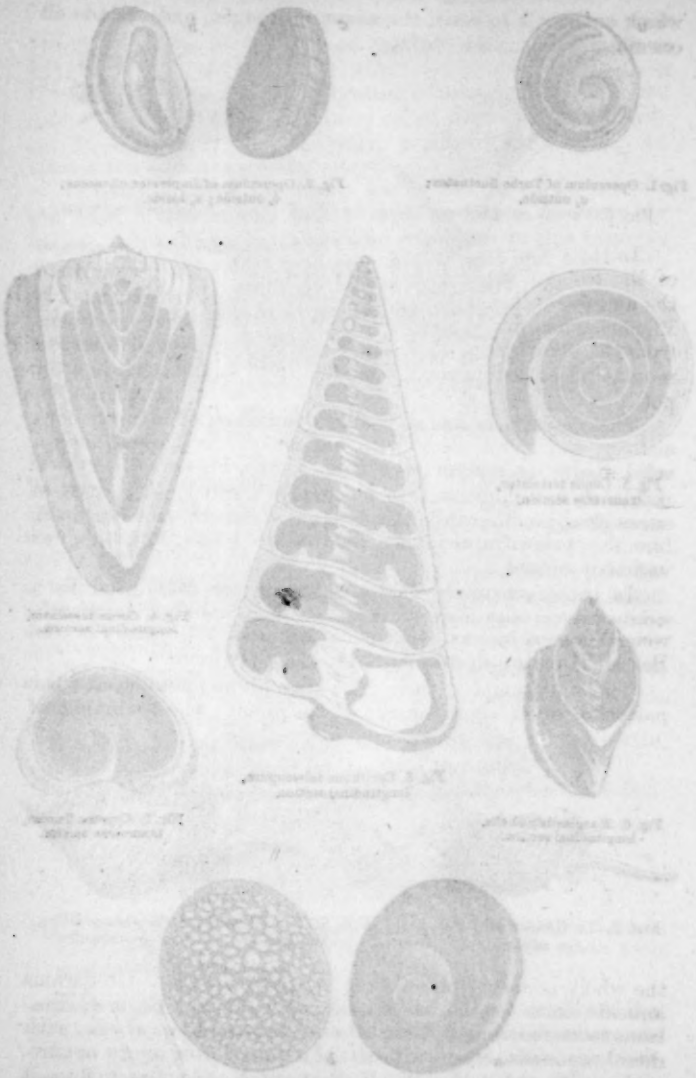


Fig. 3. Operculum of Turbo Sarmaticus—*b*, exterior surface; *a*, interior surface.

OPERCULA AND SECTIONS OF SPIRAL SHELLS.



which enables it to resist the summer drought, and exclude all enemies.

FIG. 5. *Carychium minimum*, highly magnified. FIG. 6. *Cyclostoma elegans.*

In the Coloured Plate, at Fig. 3, is represented a specimen of the foreign land-snail, *Tropidophora carinata*, presented to the author by that indefatigable traveller, the late Madame Ida Pfeiffer, which was brought *alive* by her with other specimens from the Mauritius. It was perfectly lively and well after six months' close confinement, wrapped up in an old sock in a tin pot.

The periwinkle has a similar operculum, of a horny consistency and spiral structure; but the exotic Turbos have a solid, shelly operculum (see Plate, p. 245, Figs. 1—3), coated inside with rich brown, and spirally marked with lines of successive growth; while the exterior is smooth, or corrugated, like the tufa of a dripping well (same Plate, Fig. 3, *b*), or variously carved.

In the great pearly *Turbo marmoreus*, so often used for a sideboard or mantelpiece ornament, the operculum frequently weighs several ounces. A specimen in the shell-gallery of the British Museum weighs more than half a pound.

The whelks and all their tribe have horny *opercula*, and the pattern is often characteristic of the genus; the operculum of

FIG. 7. The Dog-whelk, *Nassa reticulata.*

FIG. 8. The Dog-whelk, *Purpura lapillus*, and a small cluster of its egg-capsules.

the whelk is *never spiral*. (See Woodcut, Fig 9.) Gregarious animals, such as the whelk and periwinkle exhibit malformations more frequently than others; thus we have whelks with double opercula, others with shells repaired after injury or curiously contorted. Mr. W. H. Rich, of No. 14, Great Russell street, Bloomsbury, W.C., has devoted much time to the collection of anomalous forms of British shells. He will be

happy to gratify any of the readers of this article with a view of his collection, which is well worthy of inspection. There are also several cases for the exhibition of abnormal shells in the gallery of the British Museum.

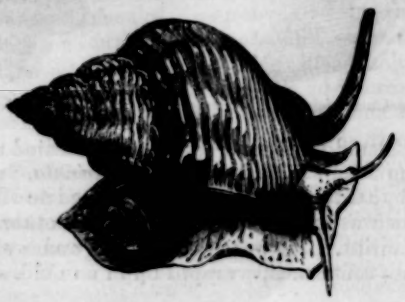


Fig. 9. The Common Whelk, *Buccinum undatum* (British).

The *Epidermis*.—The exterior of the shell of the whelk (see Woodcuts, Figs. 7—9) is invested with a thin, straw-coloured membrane whose existence is scarcely recognized. Shells from a quiet soft sea-bed often have a coat like brown velvet. Many exotic Tritons are remarkable for their rough cuticle. Arctic shells, also, such as *Modiola*, *Astarte*, *Cyprina*, have, when taken alive, a very dark-brown epidermis, entirely covering their surfaces. Fresh-water mussels and melanias (see Woodcuts, Figs. 10—12) are also conspicuous by their olive or chesnut-coloured skin.

Fig. 10. *Dreissena polymorpha*, showing foot, byssus (*b*), and respiratory siphons.

Fig. 11. Three *Dreissenæ* attached to Caspian Cockle.

This living membrane extends beyond the margins of the valves in a fringe or sheath, and protects the shell from decomposition by chemical action.* The mollusca inhabiting fresh water are especially exposed to corrosive action, either from

* In fact, it fulfils exactly a similar office to the human scarf-skin, having life without sensation, it protects the shell whilst the animal lives.

carbonic acid in solution, or dilute sulphuric acid from the decomposition of iron pyrites. But the action is especially manifested in those stagnant waters where the first probe of the collecting-rod disengages from the mud an abundant stream of bubbles of sulphuretted hydrogen. In such situations the spiral shells—for example, *Bithynia*—have lost the ends of their spires, and the discoidal shells, like *Planorbis*, have been found with a small hole caused by the dissolution of the inner whorls.

The great and ponderous mussels of the American rivers, and even the fresh-water unios and anodons of our own streams (see Woodcut, Fig. 12) are often externally eroded, and the cause has been the subject of much speculation. The umbo is the part first formed, and consequently that where the epidermis is thinnest and has been longest exposed to the action of the elements, and it is this portion of the shell which is most corroded. The epidermis of *Trigonia* is formed of a layer of nucleated cells, difficult to detect, however, in the state in which they are usually sent home (*i. e.*, well cleaned).

FIG. 12. *Unio tumidus*—River Lea. *u*, the umbo of the right valve; *l*, the ligament; *f*, the foot; the arrows indicate the respiratory currents.

Dr. Bowerbank wrote a paper to show that the epidermis was a very highly-organized structure, not only endowed with vitality like our cuticle, but furnished with vessels appropriate for and capable of repairing any injury it might sustain (*Micr. Soc.*, 1843). These observations, however, have not been confirmed.

Shell-structure.—Shells are composed of carbonate of lime, with an animal basis. There is no appreciable amount of phosphoric acid, so that shells or shell-sand have no chemical value as fertilizers. The French chemist, M. E. Fremy, found that the composition of shell was carbonate of lime, with not more than one or two per cent. of phosphate of lime. When treated with hydrochloric acid, there was left a brilliant felt-like organic residue, not soluble in hot water, like horn or gelatine, and insoluble in alcohol and ether.

This substance, which is isomeric with *osseine* in bone, he named *conchioline*. It sometimes exists in such large proportions that, like the animal basis of human bone, the lime may be dissolved out with weak acid, and the film of conchioline will remain with its peculiarities of structure.

Formerly, shells were supposed to have a merely crystalline structure; in fact, that they were a mere inorganic exudation. Look, for example, at the exterior of the operculum of *Turbo sarmaticus* (see Plate, p. 245, Fig. 3, *b*) how exactly it resembles tufa formed by spray on a limestone rock (the mantle of the animal does not continuously cover it, on the contrary, it is the door which, when closed, shuts in and protects the mantle; but at times it certainly does cover it, for it deposits on each little eminence an additional layer of shell-matter); or at the broken tube of the great *Teredo* (*Furcella*) of Java, which is more than two feet in length, and half an inch in thickness; or at the shell of the fossil Belemnite and recent *Pinna*, they have a fibrous structure, which might easily be mistaken for mineral. Drs. Bowerbank and Carpenter have advocated the views taken by botanists and anatomists, namely, that the hard tissues of shells are formed by deposits of lime in cells, or upon layers of membrane. Mr. G. Rainey, having observed that when salts crystallize in syrup, they assume a globular or other concretionary form, not geometrical, was led to imagine that a close imitation of shell-structure might be produced by causing carbonate of lime to deposit in minute concretions, which, coming in contact, become polygonal in the course of their growth. We have every reason to believe that the cells are formed *first*, and then that lime is deposited in them afterwards, just as the hard tissues of seed-vessels, the albumen of the vegetable ivory, and the silicious cuticle of grain is formed.

Dr. Bowerbank, however, has been misled in the attempt to compare the shell and the formation of shell too closely with that of *bone*, a highly vascular structure capable of absorption and internal repair, being permeated by canals in which the blood circulates.

If we examine any immature shell, we shall find the lip, or growing margin of the shell, much thinner than the rest of the shell, and, indeed, quite soft. The mucus of this soft, growing edge is found to contain granules, which are, in fact, incipient cells destined to unite and form the calcareous matter of the future shell-wall. The gradual formation of shell may readily be traced in all its stages.

There is an intimate connection between the mantle of the mollusk and its shell. The oyster, as we see it on the supper-table is much smaller than its shell, and adheres only by its glistening shell-muscle; but when alive, its *mantle*, extended to the very edge of the valves, lining the whole interior, and having a slight adhesion, especially at the edge of the valves, which is speedily ruptured, however, when the poor animal is forcibly invaded.

The "carrier-shell" (*Phorus*) cements other shells, and stones, and fragments of coral to the growing lip, and they remain firmly attached, forming a spiral round the suture. In this case, the hold of the mantle must be strong, or the animal must remain quiet for a while every time it adds a fresh bit to its grotto.

The section of any pearly shell exhibits an immense succession of fine and smooth layers. If polished or worn ever so little, these laminæ will be cut through, and their edges will present a series of parallel lines. In the nacreous shell of *Haliotis*, the layers are corrugated, so that a single layer might serve to give the pearly effect. In porcellanous shells, the entire structure is composed of layers of cells, much metamorphosed, arranged in three distinct strata, the direction of each of which is different (see Plate, p. 245, Fig. 5, transverse section of *Conus tesselatus*, Born). When seen in section, each stratum is found to be composed of many vertical plates arranged sometimes transversely, sometimes lengthwise, according to the genus. Pearly shells and fibrous shells, such as *Pinna*, are like aragonite, biaxial, and prismatic, when examined with the polariscope. Porcellanous shells, like calcite, are rhombohedral and uniaxial.

The prismatic structure of certain shells is well illustrated by the fossil *Hippuritidæ* from the cretaceous beds; the annexed Woodcut (Fig. 13) taken from the author's paper on Hippurites (Quart. Journ. Geol. Soc., 1855, vol. xi., p. 47, Fig. 12), represents part of the rim of *Radiolites Mortoni*, of Mantell, from the lower chalk of Sussex. (Traced from the original specimen in the Museum of the School of Mines, Jermyn Street.)

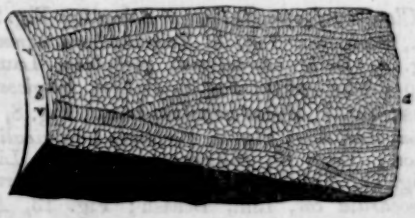


Fig. 13. Portion of the shell-wall of the lower valve of *Radiolites Mortoni*, Mant. Lower Chalk, Sussex. *a*, the outer edge; *b*, the inner edge; *c*, *c*, dichotomous impressions.

A structure analogous to the chambered shell of the cephalopod occurs in the thorny oyster, or *Spondylus*; in aged specimens, the shell, instead of increasing in size, becomes thickened in its interior by the addition of inner layers of shell,

which are distinct from the outer, and from each other. The cavities thus formed are found to contain water, which, however, evaporates after the specimens have been placed in a dry situation for a long period: but the water is again absorbed by immersing the specimens for a sufficient number of hours. This reduction of the inner space appears to be effected in order to counteract the continued increment of the shell (by deposits of new shell-matter, along its margin from the border of the mantle) at a greater rate than is required for the accommodation of the soft parts of the animal.

The tubes of *Vermetus* (see Coloured Plate, Fig. 9), and *Magilus*, and the apices of *Triton*, *Turritella*, and *Euomphalus* become either partitioned off or filled up solid, in the continued growth of the animal.

Shells owe their variations in form to a number of circumstances. Those which assume a spiral, vary in being either turbinated or discoidal in their growth, and again, in the infinite gradations between the extremes of these two. The shape of *Conus* (see Plate, p. 245, Fig. 4), is an inverted triangle, that of the telescope shell (*Cerithium telescopium*, Fig. 8) trapezoidal, and so on. The turbinated shells again merge into forms in which the whorls become detached with age as in *Vermetus* (Coloured Plate, Fig. 9), and *Siliquaria* (Fig. 10), or a nearly straight tube like *Dentalium* (Fig. 8). The discoidal shells graduate into forms having fewer and fewer convolutions, and wider and simpler mouths, until at last, in forms like *Patella* (Coloured Plate, Fig. 6), all spirality is lost, and we have only a tent-shaped cover.

DESCRIPTION OF COLOURED PLATE.

Fig. 1, *Cleodora pyramidalis*, L., Atlantic; Fig. 2, *Bulimus regina*, Fer., Amazon; Fig. 3, *Tropidophora carinata*, Mauritius; Fig. 4, *Helix* (*Anastoma*) *globulosa*, Lam., Brazil; Fig. 5, ditto (under side); Fig. 6, *Patella longicosta*, Lamk., West Indies; Fig. 7, *Murex adustus*, Lam.; Fig. 8, *Dentalium elephantinum*, Red Sea; Fig. 9, *Vermetus lumbricalis*, Gm. sp., West Africa; Fig. 10, *Siliquaria anguina*, Linn., New Guinea; Fig. 11, *Waldheimia australis*, Quoy, Port Jackson; Fig. 12, *Isocardia cor*, Lin., British; Fig. 13, *Aspergillum vaginiferum*, Lam., Red Sea; Fig. 14, *Chiton squamosus*, Linn., West Indies.

DESCRIPTION OF PLATE (PAGE 245)—OPERCULA AND SECTIONS OF SPIRAL SHELLS.

Fig. 1, Operculum of *Turbo fluctuatus*, Mazatlan—*a*, external surface; Fig. 2, Operculum of *Imperator olivaceus*,

also from Mazatlan—*b*, external surface, *c*, interior; Fig. 3, Operculum of *Turbo Sarmaticus*, L., from the Cape of Good Hope—*b*, exterior, *a*, interior; Fig. 4, Longitudinal section of *Conus tesselatus*, Born., to show the thinning of the internal whorls; Fig. 5, Transverse section of the same shell; Fig. 6, Longitudinal section of *Marginella glabella*, Canary Islands, showing four spiral ridges on the columella; Fig. 7, Transverse section of a Cowry (*Cyprœa Turdus*); Fig. 8, Longitudinal section of telescope-shell (*Cerithium telescopium*, L.), from Indian rivers, showing one spiral ridge on the column, and a second on the wall of the shell.

(*To be continued.*)

NOTES ON THE HABITS OF SOME LEPIDOPTEROUS LARVÆ.

BY THE REV. D. C. TIMINS, M.A., M.E.S. LOND. ET OXON.

THE processionary-moth (*Bombyx processionea*) is tolerably abundant in European collections, but the very singular habits of its larva seem to have escaped the notice of writers on entomology. I have never met with a detailed description, so venture to note the following facts, results of personal observation.

The larvæ of *B. processionea* lives in society; fifty or sixty individuals uniting to spin a common "nest." These "nests" are generally spherical, or nearly so, and are composed of very coarse network of hairs spun together. Their colour is a dull brownish grey, and they are extremely dangerous to handle, the hairs of which they are composed being highly irritating, producing very painful swellings, attended with inflammation. Within these nests the larvæ spend their days, issuing forth toward evening for the purpose of devastating the neighbouring trees. Most species of pine and fir are exposed to their ravages; but the picturesque "umbrella pine," so common along the coast of Provence, sometimes escapes without injury, *B. processionea* preferring any other species of pine if accessible. I have sometimes met these larvæ feeding during the day, but for the most part they are certainly night-feeders. They march forth in a long line, single file, one after another, each touching the one in front. They go wherever the individual who leads chooses to take them, and it would be a subject of curious speculation to imagine *how* these larvæ elect their

leader, and *why* they follow him so obediently; and by what means one individual obtains authority over his fellows. The line marches along until a suitable tree is reached, then the larvæ dispersing among the branches, commence their work of destruction. It is probable that they return in the same order in which they set out, but I have never had the good fortune to see them re-enter their nests. When they are on the march, if you knock the leader away, the whole line halts and remains stationary until the chief has resumed his place. If you kill the leader, the line at first remains quiet, then after a little time falls into confusion, various individuals going hither and thither, apparently bewildered, possibly searching for their leader. Presently they reform line under a new chief, whose direction they obey as they obeyed his predecessors, and continue their march. If you knock some individuals out of the line, their fellows will halt and wait until they have resumed their places, but if you kill or disable any, the remainder, after waiting for some little time, will close up their diminished rank and proceed on their way. They march straight on, heedless of danger, and well they may, for you had better not touch them without gloves. The hairs with which they are covered are so poisonous that it is said death has followed upon handling these larvæ; this, however, I should think due to a very diseased state of the blood. Birds, those enemies of the insect tribe, do not seem to prey upon these larvæ, which appear thus to increase unmolested. The ravages which they commit among the firs and pines near Hyères and Cannes are very great; I have often counted 100 nests in the course of a single ramble. I am at a loss to account for the very poisonous nature of these creatures; I have subjected their hairs to careful microscopic investigation; they are certainly formidable looking weapons, jagged and barbed on each side; but this is the case with the hairs of other species, which are harmless (*e. g.*, our common *Bombyx pudibunda*). There is a long bulb at the root of each hair, which I have conjectured to be a poison-bag, similar to that found in venomous serpents. This is merely a conjecture, however, as the bulb in question *may* be only the usual root of the hair, but I give it here as being the only way of accounting for the poisonous nature of these hairs which has occurred to me.

When about to assume the pupa state, about the month of April, these larvæ quit their nest in the usual order, and often traverse very considerable distances before finding a place suited to their purpose. They bury themselves, and form a rough cocoon of earth, hair, etc., at a depth of an inch or two below the surface. Hence the choice of a proper locality is a matter of importance, as the larvæ cannot form their cocoons

in stony ground, nor among the rocks of mica schist which abound in Provence. Accordingly they wander about, still under the guidance of their leader, until a suitable place is reached; then, as if by common consent, the line breaks up, and each larva proceeds to bury himself, near his fellows, so that where one cocoon is met with by digging, others are sure to be found close at hand. I may mention that I have never succeeded in rearing the perfect insect, all my pupæ having died, probably from not having the choice of ground when in captivity.

Another larva, whose habits are worthy of note, is that of the magnificent *Charaxes Jasius*, the prince of European butterflies. This glorious insect is very local in Europe, occurring only in Provence, near Hyères for the most part; and, it is said, in one or two localities in Spain. The larvæ I have found pretty commonly near Hyères: at Cannes none were to be seen, nor were any met with in the Estrello mountains, although the food plant (*Arbutus unedo*) abounds there. This larva is of a curious shape, the middle segments being very thick, and those toward the head and tail gradually tapering. The head has a species of mask with four horns, corresponding quaintly enough with the four tails on the wings of the perfect insect. This larva feeds only in the sunshine, and must of course be looked for only on those leaves which are exposed to the sun's rays; all attempts to induce it to feed in the shade prove fruitless. The creature would sooner die than eat except in the bright sunshine! It forms a slight silken web, very soft, and of a brilliant white colour on the leaf, not for a *covering*, strangely enough, but for a *couch*. This is, as far as I know, the only instance of silk being produced by a member of the *diurnal Lepidoptera*. The larvæ being of a bright green colour, similar to that of the food plant, are very difficult to find, and often are overlooked, even by sharp-sighted entomologists. They adhere with wonderful tenacity to the leaves on which they feed. No amount of shaking or beating will dislodge them; in order to obtain them it is necessary to examine each leaf carefully (that is, of course, each leaf on the *south* side of the plant). The larva grows very slowly, being hatched about July, and rarely attaining its full size until the following May. Before each change of skin it suspends itself from a branch by the tail, and when the change is effected, the skin of the head is left behind, horns and all, like a mask! This insect is exceedingly difficult to rear, a very slight touch will kill the larva or pupa; and to rear it in England is next to impossible, first, on account of the scarcity of its food plant; secondly, because we have so little sunshine during the spring; thirdly, because our summers are not warm enough to bring

the pupæ to maturity. However, I have managed to rear a *very few* out of a large number of larvæ; several emerged crippled in the wings, and the experiment altogether was almost a total failure, as we only obtained *two* good specimens out of twenty-three healthy larvæ, which we brought from Hyères in April last. Feeding them during the journey was of course very difficult, and the change from a hot climate to a cold one did much mischief. When this larva is full fed, it suspends itself by the tail, the head curled round towards the tail in the usual manner of diurnal lepidopterous larvæ. In this position it remains for ten or fourteen days, during which time the *least* touch is fatal. At the expiration of that period the skin cracks at the fourth segment, and the bright green pupa emerges, the old skin shrivels up (leaving the pupa free) the "mask" alone remaining. The pupa state lasts but a few days, the markings on the wings soon appear, and are rapidly developed, the antennæ and legs assume their proper colours, and the perfect insect emerges (always, it is said, at *noon*) about the first week in June, sometimes earlier. The perfect state is usually of very short duration; for the young larvæ are found in July and August, the parent insect disappearing about the same time. Occasionally, however, the perfect insect survives until the winter; indeed, *once* I saw it on the wing in December, but this was considered by French entomologists as quite an abnormal appearance. *C. Jasius* flies with amazing rapidity, and it is very difficult to catch on the wing, taking alarm at even the distant approach of the entomologist, and flying off at a marvellous speed.

IRON AND STEEL IN THE CONSTRUCTION OF SHIPS AND BRIDGES: THEIR ADVANTAGES AND DISADVANTAGES.

BY PROFESSOR McGAULEY.

A GREAT revolution has taken place in two of the most important branches of construction: the "wooden walls of Old England," which for ages were justly considered its impregnable bulwarks at home, and the infallible means of asserting its superiority abroad, have been discarded; stone and brick, which were relied upon as affording a power of crossing rivers, since the progress of civilization enabled mankind to be independent of fords, inflated skins, and other such rude, inconvenient, and unsafe appliances, are now almost equally fallen into disuse for such purposes. The transition has been, in many respects, so sudden, and iron and steel, which have supplanted wood in the building of ships, and stone and bricks in the erection of bridges, are so different in properties from the materials hitherto employed—while, at the same time, so brief has been our experience with regard to them—that we may be considered as, in a great measure, working in the dark, as far as they are concerned. This is a circumstance the more serious, as on the proper construction of our ships depends even the safety of our country, and on the proper construction of bridges the security of our lives, when passing on or beneath them.

It is certain, such are the inducements held out to the use of iron and steel, both for ships and bridges, that a return to the materials formerly employed is out of the question. A wooden ship would be exposed to almost certain destruction by the projectiles employed in modern warfare. And such are the spaces now, in so many cases, to be spanned in bridge-building, that the erection of the structures indispensable to our present system of engineering would be, not only very expensive, but often impossible, with either stone or brick. The widest stone arch in existence, that over the Dee, near Chester, is only 200 feet in span; the main spans of the Menai tubular bridge are each 460 feet wide.

That iron should be so generally used for almost every purpose, is but the natural consequence of its abundance, its cheapness, and its great strength. Comparing the cost of its production at present with what it was in former times, it is evident that it could not be employed, until now, on the present enormous scale of consumption. Many circumstances contributed to limit its use, until a recent period. From the method adopted in smelting, it could be obtained only to an

amount that was practically limited; and such was the imperfection of the machinery employed in moulding it to the forms it was subsequently required to assume, that it could be worked only in masses of a size which at the present day would be considered utterly insignificant. The possibility of using it on the present immense scale supposes a combination of circumstances which did not formerly exist, and which could be brought about only by long-continued exercise of enterprise and ingenuity.

Iron is the most generally diffused of all the metals. This, looking to the ordinary economy of Providence, evidently points to its wide-spread application. It is, however, one of the metals most difficult of reduction. This arises from its powerful affinities, which also cause it to be so extremely perishable. The difficulty which attends the extraction of iron from its ores prevented its use until long after mankind had attained a considerable amount of civilization. Hence in prehistoric, and even in the earlier portions of historic times, recourse was had to metals which are still both scarce and dear. Bronze was the universal substitute for iron; but, though great hardness was imparted to it—greater, perhaps, than is possible to us—its attendant brittleness, in some cases, and a limited supply in all, placed very narrow bounds to its application. Iron possesses a combination of good qualities which, taken in connection with its abundance, causes it to leave every other metal far behind, when there is question of utility.

One of the most valuable properties of iron—its capability of being cast in moulds—and one which it still retains in its best form, that of steel, was most probably unknown, and most certainly was unapplied in former times. Cast iron, with us, is far cheaper than malleable, and for a great variety of purposes answers at least as well. But, by the modes of manufacture anciently practised, it could not easily have been obtained; and were it even attainable with facility, the methods of manipulating it, now employed with such success, were then undiscovered. Casting iron is, with us, a very simple operation: it could not have been so in former times, on account of the difficulty of forming suitable moulds. This difficulty has been entirely overcome, within a comparatively recent period, by the adoption of sand, an improvement due to a Welsh shepherd boy. The use of sand for the purpose had been previously attempted, but without success: its general application to this most important purpose afforded facilities in the manufacture of cast iron which had been until then unknown.

The exclusive use of wood in the manufacture of iron, in

former times, imparted to the product qualities which it now rarely possesses, but set very narrow limits to its production. When the value of that metal began to be properly understood, and the demand for it, in consequence, became considerable, the rapid destruction of the forests which ensued had so injurious an effect upon its manufacture, that the quantity of iron made in this country fell to one-fourth of what it had previously been.

A mode of escape from this embarrassment, also, was soon devised. It might be supposed that mineral coal, in the form of coke, would be universally employed as a substitute for wood, when its applicability to the purpose was once ascertained. Such, however, was not the case. The use of coke is attended with difficulties which were not suddenly overcome—which were not, indeed, entirely surmounted before the power of the blowing-machine was augmented by the invention of the steam engine: until then blowing had been effected by that clumsy and imperfect contrivance, the bellows. When steam power came into use, the bellows gave place to the cylinder and piston, the capabilities of which were, practically, unlimited.

The progress of the iron manufacture towards perfection, once begun, was very rapid. It was again almost revolutionised by the introduction of the hot blast. Though the saving effected by this may, at least plausibly, be disputed, there can be no doubt that it is accompanied by peculiar advantages. Thus it renders possible the employment of coal, and even anthracite, and it enables us to utilize inferior ores. The adoption of coal instead of coke leads to an immense saving, on account of the gases, which are the most valuable portions of the fuel, and which formerly were wasted, being economized.

There are, it is true, certain serious objections to the use of coal in the smelting of iron. Thus, the sulphur it usually contains, and from which even coke is not free, causes the iron made with it to be *red short*—that is, to have the very objectionable property of being brittle under the hammer at a red heat. So little as 0.03375 sulphur destroys the property of welding, and a still smaller amount of it renders the metal utterly unsuitable for armour plates. The phosphorus, which also is likely to be present in coal, causes the iron to be crystallized—that is, renders it *cold short*, or brittle when cold. It is worthy of observation, that phosphorus, to a certain extent, counteracts the effect of sulphur; it sets free carbon, which combines with and removes the sulphur. It is possible, however, to get rid of all these mischievous ingredients: but the hot blast cannot yet be entirely depended on for the production of superior iron.

Numerous other improvements of great importance have been introduced into the iron manufacture, and valuable machinery connected with it has been invented. As an example of the former may be mentioned the process of *boiling*, and of the latter the *steam hammer*, without which it would be impossible to mould the enormous masses of iron required for ship-building and other purposes. But, of all the modifications which the manufacture of iron has undergone, that of Bessemer is probably the most valuable. It enables us to obtain excellent steel at a cost little higher than that of iron; and when the great difference between the strength of iron and steel is considered, the advantage of this will easily be understood. We may observe that, while the tensile strength of pure malleable iron is only 18,000 lbs. per square inch, that of good steel is 130,000 lbs. As with the hot blast, so with the Bessemer process, there are some difficulties yet to be overcome, since, when steel for very important purposes is required, it must be made by the old method.

In considering the fitness of iron as a material for ships and bridges, and particularly for the latter, one most dangerous defect to which it is liable must be taken carefully into account, namely, its tendency to crystallize, and thus to lose a very large portion of its strength. It appears from Mr. Fairbairn's experiments, that with constant changes of load, or with the same load, but with constant disturbance of the metallic molecules, from vibration, fracture will, in time, certainly ensue of itself. And it has been ascertained that an iron girder will break with about 400,000 changes of load, accompanied by vibrations: a fact which but too clearly shows that the spontaneous destruction of our iron bridges is but a question of time, and not even of a very long one. The explanations of this very alarming fact, the danger from which is, unfortunately, not even confined to bridges, but extends to the axles of locomotives and carriages, and to the various portions of machinery, which from time to time so unexpectedly give way, is found in the restoration to their primitive form of the crystals which had been elongated and mutually entangled by the hammering to which the iron is subjected during its manufacture.

It might be supposed that steel, from its tensile strength, being so much greater than that of iron, would be, in every instance, far preferable to iron. Such, however, is not the case. If, for example, steel is used in the formation of a girder, its thickness may be much less than if iron were used. But this very circumstance, as it is almost equally liable to oxidation, causes its strength to be impaired with much greater rapidity. Thus, a plate of iron half an inch thick is much less weakened by oxidation to the depth of the sixteenth of an inch than a

plate of steel, which at first is only a quarter of an inch thick. In the one case, the strength of the plate is diminished only to the extent of one-eighth: in the other, with the same amount of oxidation, to the extent of one-fourth. In the former case the plate would stand, when in the latter it would be sure to give way. Again, it might be supposed that steel would answer, best where violent concussions are to be withstood, and that, therefore, it would be an excellent material for armour plates. The reverse is, however, true. Steel is strong only when exposed to a force that is slowly applied. A cannon-ball which would cause only indentations in iron, or, at the worst, merely pass through it, would dash a plate of steel to pieces, dealing destruction, most probably, to all those in its vicinity.

The construction of ships and bridges of iron, and especially of the former, supposes the power of producing iron bars and plates. As the mode of forming these, except on a very limited scale, and in a very imperfect way, was unknown until near the close of the last century, iron ships and bridges must necessarily be of very modern invention. There has been by consequence very little experience regarding them: it is, therefore, the more necessary that we should bring to bear on so important a subject, everything we know regarding it.

In comparing the fitness of iron as a material for ships with that of wood, it is requisite to know their relative strength. The tensile breaking strain of iron greatly exceeds that of the very best wood. That of malleable iron is to that of dry English oak as about four to one; and, taking into account the weakness caused in the case of plates by riveting, as two and three-tenths to one. If, however, the riveting diminishes the strength of the iron, on the one hand, it increases the strength of the ship, as a mass, on the other; since, by means of it, the plates are united firmly in every direction. Considering the injuries to which ships are liable, it is not enough to bear in mind mere tensile strength. A compressing strain is often a great source of danger to them. The resistance of malleable iron to such a strain is to that of dry English oak, as seven to one. On the whole, however carefully constructed, a ship of timber is greatly inferior in strength to one properly made of iron.

Iron may be used either partially or exclusively, in the construction of ships. Each mode of proceeding has its peculiar advantages and disadvantages. Thus an iron vessel, timber-sheathed, and copper-fastened is greatly superior to one of iron, as far as fouling is concerned, and it is considerably lighter. But these advantages would be at an end, if a means were discovered of preventing the adhesion of animals or vegetables to the bottom of iron ships, and if steel were to

become so cheap as to be applicable to the ordinary purposes for which iron is now used.

Whatever the materials of which merchant vessels shall still be constructed, we have scarcely a choice with regard to ships of war. Our wooden walls belong to the past. We must henceforward depend on our walls of iron. The rams and improved projectiles at present in use would soon send the largest vessel of timber to the bottom. The contest between projectiles and armour is still undecided. It may, perhaps, be admitted that the projectiles already in use would, under favourable circumstances, penetrate any armour a ship could carry. But in battle such circumstances can scarcely ever exist. A projectile fired against a certain plate in a direction exactly at right angles to it may penetrate it without difficulty, while impinging at a less angle, it will glance off, after having done little or no mischief. The chances are many to one that in battle the angle of incidence will not be a right angle. There is, therefore, no well-founded reason for hesitating about the use of armour, and this can scarcely be applied with effect except to an iron ship.

Our only considerations at present are the comparative strength and durability of timber and iron ships. We have nothing to do with their form or armament, their sailing power, or their capability of efficient ventilation; though all of these must be more or less modified by the use of iron in shipbuilding. The superior strength of an iron ship is derived, not only from the nature of the material, but from the forms which may be given to it. The ponderous beams of the timber ship have been replaced by a much lighter, and at the same time stronger combination of plates and angle iron, so arranged as to afford the greatest amount of strength with the least expenditure of material. The resistance to fracture in every direction, afforded by a hollow iron beam or girder, consisting of plates judiciously arranged so as to prevent a yielding in any direction, is marvellous to those who have not studied the subject. Of all the forms which have been given to the ribs and other portions of a ship requiring enormous strength, the cellular is the most effective. It has the additional advantage of affording spaces for the stowage of water, without its occupying any otherwise disposable room, a circumstance of great importance on board a ship.

There is, however, one objection to the use of iron in shipbuilding, which has often caused serious doubts as to the propriety or even the possibility of continuing to employ it for the purpose. Iron is the most perishable of the common metals, not even excepting zinc, which, though more strongly electro-negative, is more durable, being to a greater or less extent

protected by a coating of oxide, which in ordinary cases soon forms upon it. The pecuniary loss caused by the rapid corrosion of iron ships has given rise to very serious anxiety both to our own and to foreign governments. This loss is so enormous that about twenty years ago the government of this country determined to abandon the use of iron ships of war. The evil is of the greater magnitude, as iron ships cost nearly four times as much as those of timber formerly in use in our navy.

Few persons have any idea of the rapidity with which iron ships are eaten away under the action of sea water. Large holes have been produced in two or three years, plates and rivets have been destroyed over a large surface, so as to put even the safety of the ship in peril. The vast number of the patents taken out for paints and other protective compounds, shows the seriousness of the difficulty, and at the same time proves the futility of the efforts which have been made to grapple with it.

The rapid destruction of the ship is not the only serious evil that accompanies the use of iron in shipbuilding. Iron ships are peculiarly liable to fouling, and this to an extent which is not only a cause of great delay, but often of imminent danger. When copper sheathing is used with wooden ships, the slight galvanic action which attends its slow solution in the sea water completely prevents the adhesion of marine plants and animals. This trifling corrosion formerly gave rise to considerable annoyance on account of the loss it entailed, and efforts were made, not without success, to prevent it. The sagacity of Sir Humphrey Davy suggested to him as a protecting agent the use of a metal at once more strongly electro-negative and less costly. Such a metal was found in zinc, which, in suffering the electric action, would save the copper. But the removal of such action from the sheathing led to an amount of fouling which soon caused all attempts to preserve the metal to be given up, and it was even considered very fortunate that at the expense of the copper, fouling could be prevented.

A sheathing of copper having been found so advantageous with wooden ships, it might be supposed that it would be equally useful with those of iron. But, instead of the copper protecting the iron, the iron would but too effectually protect the copper, and an enormous galvanic battery being produced, the destruction of the vessel would proceed with fatal rapidity. Were it possible entirely to prevent contact between the iron and the copper, the destruction of the former might be averted, but all attempts in that direction have been vain, so many circumstances are liable constantly to occur which render every precaution that may be taken unavailable.

Neither can the iron be protected by paint, or any other similar composition. All those compounds hitherto tried have failed, the corrosion, commencing in points, and spreading under the paint in every direction. Indeed, in proportion as they are successful in preserving the iron, they are mischievous in giving rise to fouling, large quantities of barnacles and weeds accumulating rapidly on the protected portions. The retardation thus caused is a source of serious additional expense. A comparatively small deposit would give rise to a loss of speed to the extent of one knot an hour, and the additional cost of fuel, seamen's wages, etc., consequent on this, is a matter of very simple calculation. Thus, supposing, for example, the average speed of the vessel to be ten knots an hour, the expense would be increased by one-tenth.

Fouling can be averted only by a clean metallic surface, on which electricity is constantly developed. It is vain to attempt the destruction of marine plants and animals by poisonous substances, the only way to prevent their adhesion is to present to them such a surface as will afford them no means of adhesion. This is best effected by the slow removal of the surface itself, on account of gradual corrosion, and the washing off of the resulting compound.

We may, therefore, conclude, that with iron, as with wooden ships, some metal must be sacrificed, and the only question that remains for solution is what that metal shall be. It is fortunate that in considering the important subject of the electro-chemical preservation of iron ships, we are not confined to the use of copper, on the contrary, a far less expensive and a thoroughly effective substitute for it is in our hands. If iron perishes in presence of copper, because it is electro-negative with reference to the copper, to preserve the iron as completely as the iron would preserve the copper, we have only to place in contact with it a metal which bears the same relation to it that it bears to copper. Such a metal is zinc, and it is the better suited to the purpose since its conductivity and other properties only just permit that amount of corrosion which is enough to secure a surface sufficiently clean to prevent fouling.

The efficiency of zinc, as a sheathing for iron ships has already been tested, and the experience of several months at a time has shown that its surface remains perfectly clean, under the ordinary conditions of immersion in the sea. The necessity for the substitution of zinc for copper as sheathing is fortunately not accompanied by increased expense, but rather the contrary. The cost of zinc is, indeed, only about one-third that of copper, but as sheathing it costs very nearly the same as copper.

There is no reason why only the outside skin of an iron ship should be carefully protected. It is true that this portion is corroded, if unprotected, with great rapidity, but every part, especially if exposed to the action of bilge or other water, rapidly decays. This general destruction might be, at least in a great degree, prevented by a judicious application of zinc, which when dissolved, or otherwise rendered ineffective, might be easily replaced. Experiments recently made at Portsmouth show that when the zinc sheathing and the iron of the ship are in perfect metallic contact, the zinc remains clean, and free from a coating of any kind. The interposition of felt, or any other imperfectly conducting material, as might be anticipated, has been found injurious. Complete contact of the metals is no more than sufficient to secure just enough galvanic action to preserve the one metal and keep the other clean.

The advantage of protecting iron ships from corrosion, is evident from the immense numbers of them annually constructed in the United Kingdom. The tonnage of the iron ships built on only six of our large rivers, during last year, amounted to nearly half a millon of tons. The value of all those at present in use must, therefore, be enormous; and their preservation from a decay which has been found alarmingly rapid must be a question of the highest importance. The application of zinc to the protection of iron, especially after its having been employed long since for the protection of copper, is a proceeding so obvious that we can only wonder it has not been long ago, and universally, adopted with iron ships; its use in that way being rather the application of a well-known principle, than a novel discovery in science. And, indeed, as Sir Edward Belcher observed at the recent meeting of the British Association at Nottingham, its application to this purpose is not new.

Among the important advantages which accompany the use of zinc as a protection for iron ships, not the least is the absence of the necessity for insulation. If copper or "yellow metal" is employed as sheathing, it must be perfectly removed from conducting communication with the iron: or it will, so far from protecting the iron, cause its destruction to be far more rapid; since the least contact between the metals will not only transfer the chemical action to the iron, but render it far more intense than it would have been had the iron been merely left to its fate. The effect on iron of contact with copper is very great. The accidental dropping of a copper coin into the bilge-water, so as to come in contact with the iron of a ship, has more than once given rise to the formation of large and dangerous holes. In the attempts made to use copper sheathing with iron ships various means have been vainly used to

secure its insulation. Thus plugs of ebonite were inserted in the iron skin, and over the latter was spread, first sheets of felt, and then sheets of india-rubber. But unforeseen and accidental circumstances have rendered every such attempt to preserve insulation unavailing.

It may be asked, Why, if zinc is so much cheaper than copper, and at the same time so effective, it did not supersede copper as a sheathing even for wooden ships. The reason is very satisfactory: it would not have prevented fouling, since the condition which is secured by its contact with iron—namely, galvanic action—would not have been sufficiently secured by its contact with wood.

There is one rather serious difficulty that attends the use of zinc as sheathing for iron ships—its attachment. The drilling of numerous holes in the iron skin would be, not only expensive, but very objectionable for other reasons. This, however, has been obviated, and by very simple means. The edges of the plates forming the skin of the vessel are kept asunder by a slight interval, which is filled up with compressed teak, and into this are driven the zinc nails which are used to attach the sheathing, and which are rendered more secure by their points being, where they come in contact with the iron rib, turned back by it into the teak. The sheets of zinc can thus be nailed to the iron skin as easily as if it were wood, and the insertion of the nails in the teak serves to wedge it more tightly in the joint. In forming the latter, it is obvious that the edges of the iron plates may be left as they come from the forge, dressing of any kind being superfluous—a circumstance which considerably lessens the expense.

Iron supplies to the engineer a most excellent material for the construction of bridges. Not only is it cheaper for the purpose than stone or brick, and more durable than wood, but it allows the construction of bridges of immense span. It may be in the form of cast iron, wrought iron, or steel. Cast iron answers well enough within certain spans, but the soundness of the casting can never be entirely depended on. In the form of voussoirs or ribs, engineers have ventured to employ it in spans of 240 feet. Malleable iron is most generally used, and invariably with very large spans—almost always in plates varying from less than a quarter to little more than five-eights of an inch in thickness. Looking to the rapidity with which iron is corroded, even in the atmosphere, how short is the period during which these plates will retain any amount of strength, without a degree of care which no one thinks of bestowing upon them. The danger from this source is not imaginary. The best constructed and most carefully preserved of our iron bridges are, as it were, melting away perceptibly.

Very recently more than *forty tons* of rust were removed from the Menai tubular bridge; but, large as this quantity was, it does not represent anything like the entire corrosion which has taken place in this bridge during the few years it has been in existence, since it consisted only of the rust which had formed on the exterior. How many additional tons would the interior and inaccessible portions have furnished, places where corrosion may be going on with an unsuspected but most dangerous rapidity. A very small extent of surface deeply corroded would suffice to endanger the stability of the largest constructions of iron, and might at any moment give rise to its sudden destruction.

The effect of air and moisture upon iron bridges must be greatly increased when, as is but too often the case, not only no effective means are taken to preserve them, but they are wantonly exposed to the most injurious influences. How long can they reasonably be expected to last, when moist clay and gravel are kept constantly heaped up against and in immediate contact with them, or when the pillars on which they, at least partially, rest are immersed in salt or brackish water. Experiments have shown that cast iron is rapidly changed, by the action of salt water, into a friable mass, closely resembling plumbago in both texture and weakness.

Independently of the danger which must arise to the public from the rapid decay of so many iron bridges, their renewal within a comparatively very short period, which, under the circumstances, will be unavoidable, must hereafter entail a most serious expense and inconvenience on railway companies, and indeed, indirectly at least, on the public. This consideration should lead to the adoption of a more rational treatment of iron bridges, and even to some attempt at a retardation of that decay which seems almost inseparable from them. Protection from moisture, with the exception of that contained in the air, is, in many cases at least, possible. But our electro-chemical knowledge might, perhaps, if properly employed, supply us with the means of imparting to iron constructions a degree of permanency almost without limit. Why do we not avail ourselves of the principle which is now being applied to the protection of iron ships—the transfer of the corrosive action to zinc. The cost of the metal which would thus be consumed, especially taking into account the ease with which it could be replaced, would bear no proportion to the expense and trouble which the frequent renewal or extensive repair of so many iron bridges must necessarily entail.

The subject of iron as a material for ships and bridges is one of the most important that can be considered. There is not one whom it does not, in some way or another, concern.

The owner of an iron ship is seriously interested in its preservation; the shareholder in a railway company ought to be anxious that the bridges on his line should last as long as possible, since the cost of their repair or renewal must be effected with money which otherwise would be his. The traveller, whether by sea or railway, is also deeply concerned, as there is the question of his safety. The general public is concerned, since it is impossible to proceed in any direction without passing under one or more railway bridges; and this, if they are allowed to corrode as rapidly for the future as at present, cannot but be attended with peril.

Iron and steel as materials for ship and bridge building possess advantages which will render their use for these purposes still more general than it is. We never can return to the materials they have supplanted. It behoves us, therefore, to make every effort to lessen or remove the inconveniences by which their use is at present accompanied. Science, if it does not now, will certainly hereafter supply us with the means for effecting this. But future safety, and a large saving in the time to come, must not be sacrificed to a trifling advantage in the present. The precautions that are taken must be wise and not specious ones. It is not unusual, for example, to contract for iron-work by weight, in the hope of securing the required amount of strength; but this important object is not to be attained in such a way. For the strength of iron and steel depends not only on their massiveness, but their quality; and the contractor may exactly fulfil his bargain as to weight, while at the same time he supplies what is vitiated by dangerous weakness.

DINOCHARIS COLLINSII; A ROTIFERON NEW TO SCIENCE.

BY PHILIP HENRY GOSSE, F.R.S.

(*With a Coloured Plate.*)

Class *Rotifera.* Fam. *Euchlanidota.*

Gen. DINOCHARIS (Ehrenb.). "Eye single, cervical: foot forked: lorica closed ventrally, with the lateral margin sharp."

Sp. *D. Collinsii* (Gosse). Lorica about as broad as long; furnished with four spines at the posterior edge, and four longer ones in the centre of the back: front and lateral margins denticulate.

Description:—Total length, when extended in swimming, ·008 inch; length of lorica along dorsal line, ·0032; ibid. to tips of posterior spines, ·004; breadth of lorica, ·0038. The lorica, viewed dorsally, has a somewhat square outline, with rounded angles; the front hollowed, the posterior edges nearly even, but set with four spines directed backwards, of which the dorsal (and inner) pair slant diagonally upwards and outwards, the ventral (and outer) pair are nearly in the line of the body. The dorsal surface is much arched longitudinally, particularly the anterior half (See Fig. 3), the highest point being about one-third from the frontal excavation. From this highest point spring two stout, long, rigid, slightly decurved spines, rather wide apart, and point backward almost horizontally. Another pair, very similar, arise from a more central point, close together, but diverge towards their tips. The lateral margins of the lorica are beset with small spines, about twenty-five on each side, like the teeth of a circular saw, the seventh, eighth, ninth, and tenth being larger than the rest. The frontal excavation is similarly toothed, but much more minutely. The whole ventral surface is delicately punctulate; the dorsal surface only in the central region, where the punctuli have a tendency to run in convergent rows. The ventral surface is wholly closed, so that the lorica is testudiniform. It is strongly convex in transverse section (See Fig. 4).

The head is quite retractile, thick, and massive in form, sub-cubical, with rounded angles; the lateral edges appear to become shelly, carrying two or three rows of small spinous teeth. The occiput forms a shelly projection, also edged with rows of teeth (See Fig. 1); this, though nearly lost in the general outline, when the head is fully extended, yet is often

left isolated when it is suddenly retracted. The front is set with strong cilia, which in action produce a vigorous vortex on each side.

The foot consists of four joints, of which the first is thick, and carries at its extremity on the dorsal side a pair of divergent spines; the second joint is very short, and slenderer; the third is longer, but still further attenuated, expanding slightly at the tip; the fourth consists of two straight, slightly decurved, moderately long, spine-shaped toes.

An eye of conspicuous size, transversely crescentic in form, and of rich ruby hue, is seated just in front of a large globose mastax, which displays the ordinary structure. I have not been able to discern the cerebral mass on which the eye, doubtless, rests. The alimentary canal is ample, commonly filled with the digestive secretions, of a clear yellow-brown hue, and with granular food. The viscera are difficult of exact definition, from the complex nature of the integument, and its appendages; but seem to present no remarkable feature.

This very attractive form was brought under my notice nearly a year ago by Francis Collins, Esq., M.D., Assistant Surgeon in the Royal Military College, Sandhurst. He kindly communicated specimens to me, from which the preceding description, and the accompanying figures were prepared. As the species appears to be hitherto unrecognized, I honour it with the name of its discoverer. Dr. Collins favours me with the following notes concerning it:—

"The new species of *Dinocharis* is found in the parish of Sandhurst, in Berkshire, and as yet only in one small pool in a fir wood between the Royal Military and Wellington Colleges, about two miles from the former and one from the latter. The pool is not more than eight feet in length by five in breadth, and from four to five in depth. It receives the surface drainage of a very small portion of the wood. The drains are open, and are almost choked with moss, and it is chiefly in one of these, close to the pool, that this interesting and curious species has been found. Both the pool and the drains are peculiarly rich in rare species of *Rotifera*. They contain also many varieties of Diatoms, Desmids, Infusoria, and indeed microscopic objects without number.

"The history of our little creature is rather curious. In September, 1864, a lady (Miss S.) was staying with me. On leaving my house she took away a bottle of water from our favourite little pool, which proved to contain specimens of our new *Dinocharis*. It was not until the autumn of last year that I for the first time saw a specimen, but then I found it in abundance. In the winter it disappeared entirely. In April

of the present year, Miss S., who had been spending a few weeks with us, again took away a bottle full of the water from the same pool. We had searched it well while she was here, but could find nothing of particular interest. After she had kept this bottle of water, however, for more than four months, she suddenly found it swarming with these interesting creatures. I may add that about three weeks ago [at the end of July] I obtained water from the same place, but could not then find anything of interest. Some of the drains leading to the little pond had been cleaned out during the course of the summer, which may possibly account for the absence of the *Rotifera*."

In captivity our little *Dinocharis* is active, rarely still, rooting among the sediment, or swimming with a smooth, gliding motion, of no great speed. If I may judge of its behaviour in freedom from what is seen while under our notice, it seems to be specially a bottom-frequenting form; for, in a phial, the pocket lens never detects it roaming freely through the water, while a pipette thrust down to the sediment invariably captures several specimens. I am not acquainted with any other form in the class with which this well-armed species can possibly be confounded, unless it be the *Polychœtus subquadratus* of M. Perty, figured (without any description) in Dr. Arlidge's *Infusoria*, Plate xxxviii., figs. 31, 32. To this species there is certainly much resemblance, but at the same time much dissimilarity, particularly in the shape of the lorica, the number of long medial spines (eight in *Polychœtus*) and in the situation of these, which are represented on the *ventral* surface. This, however, may be mere inaccuracy of observation. Indeed, considering all things, I would not be quite sure that this form of Perty's was not founded on our *Dinocharis*, very carelessly and untrustworthily delineated. Should it, however, prove to be so, M. Perty's name cannot be retained, since there can be no doubt of the generic affinity of our species with the other members of *Dinocharis*. Dr. Leydig, indeed, supposes Perty's *Polychœtus* to be a crustacean; but in this he is certainly mistaken.

EXPLANATION OF THE FIGURES.

Fig. 1. *Dinocharis Collinsii;* dorsal aspect. Fig. 2. Ibid. ibid. (the armature of the lorica omitted, in order to a clearer display of the viscera). Fig. 3. Ibid., lateral aspect. Fig. 4. Ibid., outline of transverse section of lorica.

Postscript.—I subjoin a list of *Rotifera*, which Dr. Collins has detected in the tiny pool above-mentioned, remarkable, not only for the number, but for the rarity of the species, as will

be apparent to those who have made this beautiful class of animals their special study:—

Floscularia cornuta	abundant.
„ campanulata	scarce.
„ (an undescribed species)	very scarce.
Melicerta (an undescribed species)	rather scarce in this pool, but abundant in the neighbourhood.
Œcistes crystallinus	scarce.
Megalotrocha velata	scarce.
Microcodon clavus	abundant.
Notommata aurita	
„ centrura	
Furcularia cœca	common.
Plagiognatha felis	
Lindia torulosa	abundant.
Monocerca bicornis	
Dinocharis tetractis	scarce.
„ Collinsii	abundant.
Salpina mucronata	
Colurus caudatus	abundant.
Stephanops muticus	
„ (an undescribed species)	
Rotifer (several species)	common.
Actinurus Neptunius	
Philodina (several species)	common.

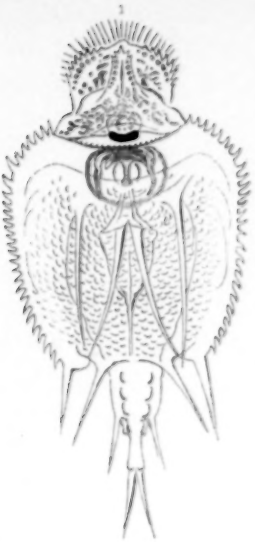
FROM KURRACHEE TO MOOLTAN.

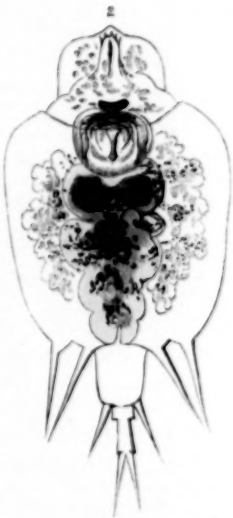
BY FRANKLIN FOX,

Superintendent Oriental Inland Steam Company, Limited.

THE monotonous chant of the Lascars calling the soundings in feet, as they dip their coloured bamboos to the river's bottom from the flatly-built steamer's bow, warn us in our gradual and winding passage up the Indus, when we may look for the grounding bump that stops our progress for a time.

"Bonée paunch poot!" "Sara char poot!" quarter less five, and a-half four feet, hint that we have not very much water to spare under us. In the dry season, from November to February or March, though the journey up the Indus is formidable from the time it occupies, the channels of the river being shallow, winding, and comparatively dried up, the climate is cool and invigorating, and the trip from Kotree to Mooltan, affords to those making it, a not by any means unpleasant experience of Indian life. But to begin at the beginning, one must "take a departure" from Kurrachee, a seaport close to the creeks forming the delta of the Indus, and which presents to us, on arrival, an appearance different from any other harbour in the world.





P. H. Gosse, ad viv.

DINOCHARIS COLLINSII.

Mag. 400 diam.

The shore, as seen approaching it, is a flat tract of yellow haze-covered sand, looking as heat-radiant as the desert itself: an intensely blue sky, of course, over it. On the right of the harbour-inlet's mouth, a cluster of dark rocks of fantastic shape, half pyramid, half ninepin, stand boldly out against the yellow beach, and on the left another mass of rock, the top of which is fashioned into a light-house, and flag-staff, has a Robinson Crusoe looking aspect. Rough stone winding steps cut out in the rock, show it to be accessible by water at all events, if not from the promontory of land which joins it, and forms the inner part of the harbour. This is the establishment of the harbour-master, and the sandy beach adjoining, devoted to ship-yard and river-steamer work, is called Manora.

The entrance to the harbour is obstructed by a bar, on which there is at high water but nineteen feet, rendering the port inaccessible to vessels of large draught, and a very uncomfortable place for ships of lighter burden when the south-west monsoon, to which it is exposed, thunders, in heavy seas and stormy squalls, at its mouth.

Large government works have been undertaken, and about three hundred thousand pounds expended for the purpose of clearing away the bar, partly by narrowing a creek called Chinee Creek, which joins the upper part of the harbour, and partly by the construction of a groyne on one side of it, extending into the sea, by which it is intended to increase the rapidity of the tide in the harbour, and thus, it is hoped, sweep away the obstruction at the entrance.

The water of Kurrachee harbour, or some creature peculiar to it, so affected the plates of an iron steamer's hull in the course of eighteen months she had lain there, that a pen-knife could be thrust with ease through her plates at places, some a few inches, some farther, apart, as if the iron were rotten wood. The appearance of the iron at these places, indicated by little circular spots, being also like rotten or rust stained wood. To test whether this is the work of an animal, or of the water, or in consequence of the plates being defective, the authorities have, I believe, sunk plates to the bottom of the harbour to try the effect upon them.

The landing at Kurrachee is at a wooden pier or jetty, and facing you, mounting its steps, is a wooden building marked "Post-office." A drive of a mile or two along a narrow causeway-road, bordered by Chinee Creek on one side and the harbour mud the other, brings you to a stone arched gate and building, the Custom House. Here you enter the town, which is laid out in square blocks of buildings of stone, of rough construction, but solid, and nearly all standing in square inclosures (compounds), surrounded by rough stone walls. Far-

ther on, past the houses of business and banks, you reach the camp, divided into civil and military lines. In the centre, nearly, is Trinity Church, with a square, stone-built tower for its steeple. Close by is the flag-staff, on which a red pendant announces once a fortnight the advent of the English mail and home news.

The train from Kurrachee to Kotree—the terminus of the steamers on the Indus, now that the railway has superseded the tedious navigation of the creeks, or the passage by the mouth of the Indus, by which formerly the water passage from Kurrachee to Kotree was made—starts at half-past six every morning, and its whistle is sounding impatiently, otherwise I might pause and dwell a little on the lions of Kurrachee—its Government Gardens, its Government House (the Commissioner's residence), its Cutcherry, and its Rere Hall, lately built, its Library and Museum, its evening drive, where an enormous rifle-target and a "blasted heath," appear to have suffered as much scorching as no doubt the reputations discussed there do: its sea-view at Clifton, and last, not least, its famous picnics and drives to Muggerpoer,* that shady abode of priests and muggurs (or crocodiles), held equally sacred in the native eye. There are some three hundred crocodiles here in about as many yards of shallow muddy streamlets, bordered with muddy grass, in which these brutes wallow. Close by is a hot sulphury spring, said to be of great medicinal power. A shady grove of trees covering in this spot renders it a pleasant retreat for visitors as well as residents, and part of the amusement of the day is supplying the resident muggurs with a live kid or goat to see the summary way in which it is disposed of; a stock of these animals for sale is kept on the spot by the natives. Occasionally a child is carried away, I suppose when a dearth of visitors (and consequently kids) make the muggurs unusually voracious, and then the Government threaten to "put down" that sort of kidnapping. But there it exists at present, and a famous old temple, and shrine, and tombs of holy men also to look at, make a visit to the shady oasis not by any means an unpleasant day's trip.

The man who, as Sterne says, travelled from Dan to Beersheba, and found "all barren," would certainly not find much to notice from Kurrachee to Kotree except an "embarras" of barrenness, which the total want of water during part of the year imparts to the level, monotonous tract of sand and stunted shrub that Lower Sind is at the delta of the Indus. A few dry water courses spanned by railway bridges that look now in the

* Sometimes spelt Muggea Poer.

"dry" season absurdly long, tell of the rushes of water that in the rains flood these plains.

Kotree, or Little Cairo as it is sometimes called, presents an agreeable contrast when you reach it full of the sand of Sind internally and externally. The shady road from the railway station, overtopped by bright green trees, arching over head till they meet, the beautiful flower-gardens round the houses, the placid river, the white-painted steamers and flats moored to the bank, recall Cairo and the Nile to one's mind's eye; and also suggest what the other parts of Sind might be with the aid of the water that makes Kotree so bright. A shady road runs parallel to the river, leading to a fort-like building and the steamers depôt where we embark for Mooltan. There is nothing in the width or appearance of the Indus here to indicate its real size and grandeur, as the father of the five rivers of the Punjaub. "Paunch" signifies five, and "aube" waters, in Hindustanee, and refer to the five rivers, the Jhelum, the Sutlej, the Chenaub, the Ravee, and the Beas, joining each other, and eventually the Indus, after running through the north-west provinces of India.* On the arrival of the morning train from Kurrachee (which has been all night on the road), and generally a few days after the mail from England *viâ* Bombay, a steamer starts for Mooltan. Each steamer takes a flat lashed on each side of its paddle-boxes (for cargo), and with these encumbrances, and little more than four feet of water to depend upon at times, the reader may imagine the navigation is peculiar and not without its difficulties. A train of barges or flats joined to the steamer and each other, so as to form a serpentine tail, of which the steamer was the head, was a plan tried, but the windings of the river are so abrupt, the stream so rapid and shallow, that this did not succeed, and it is found now the more the steamer and her barges are assimilated together to move rapidly and in unison, the more successful they are in combating the obstacles the river opposes. To the energy and enterprise of the Oriental and Inland Steam Company are due the experiment alluded to, and the merchants of Sind and the Punjaub are indebted (although the experiment failed) to the same company for having placed the new and fast steamers on the river, where there were only the old vessels of the moribund Indian navy, since replaced with some additions by the Indus Flotilla Company.

* Thornton says in his *Gazetteer of India*, "With respect to the propriety of the designation, it is, however, to be observed that there are in fact six rivers,—the Indus, the Jhelum, the Chenaub, the Ravee, the Beas, and the Sutlej; but as the Beas has a much shorter course than the others, it seems to have been disregarded when the name of the country was bestowed."—ED.

November 5th, 186—. Shook myself down on board the river steamer! Reached the first wood station, Onapore, at dark, here we lash to the bank, and take in wood fuel. All sleep on deck on account of mosquitoes taking charge below.

The river's bank here is a low sandy plain, patches of sandy islets intersect the river course frequently, and now and then the bank is a bluff of muddy sand, with trees of larger growth than the shrubs which appear to border it. The course of the stream is apt to vary through the sand it carries with it, which, lodging on these islands, in time changes the channel. We take a pilot at every wood station. The great guide in the navigation (in addition to local knowledge) appears to be the eye; the pilot is constantly on watch, altering the vessel's course where little peculiar ripples on the smooth, muddy surface of the river indicate shallow water. Our steamer draws only four feet of water, and we keep sounding with bamboo poles, marked to feet, on her and on the flats all day, the Lascars constantly chaunting the depth they have. The pilots are Sindians—intelligent fellows, who have worked in the Bherrie, or large river boats, up and down the river, all their lives. They are organized by Government, and under the control of the Conservator of the Indus. Each one wears a red sash, with a brass plate on it, as a badge of office; and they get about eighteen rupees (twenty-six shillings) a month as pay.

November 6. Passing the same sort of scenery as yesterday, all day. A line of trees in the far distance shows the difference between the river's breadth to-day and in the floods. Sometimes it is so capricious in its direction, that villages originally on one bank are discovered, when the floods subside, to be on the opposite side to where they were before; and it not unfrequently happens they are washed away altogether. At night we reached Gopang, the second wood station. Went on shore; found a fine beaten road, and a village of mud huts. During the latter part of the day we had passed some small forests blossoming with yellow flowers; at other places groups of breeding camels and their little ones, watering; and some picturesque native boats being tracked up stream by their crews, the towline being led from the top of the boat's mast. At places, as you pass, the stream comes with a rush, and you see large masses of sandy bank crumbling into the river bodily. They said, a man on horseback, riding by here, was suddenly engulphed in this way, and his body picked up fifty miles down the river.

November 7. The same sandy shore, with here and there small forests. Current very strong, so we did not reach the wood station.

November 8. Reached Bembra (the next station) at half-past ten A.M. Went to see the village mud huts, and two seedy-looking plaster mosques. At night, pulled up at the bank. Went for a walk through a real Sind wood; startled a lot of grey partridges roosting on trees overhead; gathered some cotton flowers and pods in various stages of maturity.

November 9. Approaching the first town of any importance, Sehwan, by name, eighty-four miles from Kotree only by land; stuck in the mud for an hour as we near it; passengers set to at whist, catch mosquitoes, and drink beer; captain, crew, and steam-pipe all roaring, and very busy till she comes off again. At Sehwan you observe a chain of hills—the Lukkee Range—extending the length of Beloochistan down nearly to the sea, and originating far off in the Hala Mountains. Every turn and winding of the river seems to bring us near to their base, though of course in reality they are a long way off. Went to see "the lion" of Sehwan, which is a magnificent tiger, kept in a rattle-trap bamboo cage. The town is composed of streets of mud houses; but there is a fine mosque, into which, after taking off my shoes, I was allowed to penetrate, across an inner square court of stone, to the tomb, where, amid crowds of worshippers, and tom-toms, reposed (which was more than I could have done) the remains of some great departed. Backsheesh, of course; and back to the steamer, hoping the tiger would not break out of his cage that evening, as he seemed pretty certain of doing some time or other soon, if he felt inclined.

November 10. Left Sehwan at daylight. The next station is called Kukan; then Seta, then Jumalli, then Baradera, then Suliana, and then Sukkur, the great place between Kotree and Mooltan. Here we arrived November 16, having passed through a continuous tract of vast sandy plain, day after day, following a winding course wherever clayey strata in the bed of the stream altered its course through the soft sand. Where there is no clay the banks of the stream are soft and yielding, crumbling away trees and all under the wash of our paddles as we pass. At intervals we passed numbers of native boats, employed in carrying the produce of the country, though many are lost in their passages. It occupies them generally about six months to get up from Kotree to Mooltan, partly sailing and partly tracking, though the passage down stream is comparatively easy. Some are employed conveying wood to the fuel station on the river, large quantities being used by the steamers.

The sails of some of these boats are as peculiar as their shape, those from Ferozepore and the Sutlej River being different to the Mooltan and Kotree ones. Some have sails laced to a

boom, making them set like a board—a "wrinkle" our yachtsmen took out from the "America's" canvas.

We now begin to find blankets on deck acceptable at night, but prefer the cold to facing the mosquitoes below. At Seta I saw large quantities of cotton growing, and came across, in my walk, a lot of green parrots, some wood-peckers, and some enormous orange-coloured bees, having honeycombs in a tree hard by. Persian wheels for irrigation are at work, everywhere there is vegetation, on the river bank, and the results show the marvellous effect even of these partial supplies of water.

As we approach Sukkur and the Sukkur Pass, the country becomes more picturesque; the usually flat banks of the river change to hill; and getting a glimpse of the town as we approach, one sees in the setting sun square buildings, with deep pillared porticoes, looking like the pictures of ancient Greece; but the massive-looking structures prove to be mud when one comes a little closer. Nevertheless, Sukkur is the most remarkable place on the passage up. The river narrows to a gorge formed by steep, rocky shores; in the centre is a fortified island, looking like a miniature Malta in its yellow clay construction, which somewhat resembles the yellow-white stone of that place in colour. This is called Sukkur Fort; and past this place the river, pent up in narrow limits, rushes with great force. This is called the Sukkur Pass, and steamers often find it hard work here to get through.

Sukkur is near Jacobabad, where the famous Sind Brigade hold their head-quarters, and keeping a line of frontier videttes, the looting Belooches are kept in check. Here our whist party was broken up; it had been composed of a Sind horseman, a post-office inspector, about to commence his tour on relays of camels and elephants, and other wild animals, and an agreeable Italian gentleman.

November 17. At evening reached Rhoda, the first wood station after leaving Sukkur. We get now out of the jurisdiction of the forest ranger of Sind in wood supplies, and depend on our own arrangements, instead of those of Government, for that necessary article.

November 18. Reached Ghobla. Here we wooded from boats.

November 19. Passing sandy islets, with armies of birds, pelicans, storks, cranes, sandpipers, swarms of geese and ducks. Here and there an alligator appears, and occasionally a white porpoise. We have a bluff sandy mud cliff on one side, a shallow sand spit on the other, and a winding channel in and out. Did not reach the station to-night, the current being very strong—not that there is much difference here between the bank

anywhere and "the station," except that at the latter there are a few stacks of cut wood on a small clearance, and at the former it is all jungle. A puttywallah, or watchman, keeps guard on the wood, and the pilots are here obtained for the next day's run.

November 20. Reached Kordrewallah at breakfast-time; a few miles from here we pass the boundary line between Sind and the Punjaub; and here also ends the patrol line of the Jacobabad warriors (Sind Horse).

November 21. Found the river a little slacker in its currents. At one o'clock reached Mulochwallah; saw some jackalls, some grey partridges, and some tiger tracks.

November 22. Getting on faster, the stream being slack, but winding amid large patches of sand-banks, much more numerous than lower down stream; the sand-patches are tenanted by alligators, looking like logs of wood with pointed ends, which, when they are startled, prove to be very ugly heads, with large jaws and fishy eyes. Their teeth are not large, but there are plenty of them. The natives don't seem to mind them a bit; and when any one—say the pilot—wants to return down the river after a day's run, or some one wishes to cross at a bend of the river, they inflate their goatskin (or mussick) with air, stream it, and jumping astride, away they go down the road cheerily! To-day we had a fine breeze, and set sails on the steamer and flats. We reached Essanpore at two P.M., and started off again at four P.M.; but there was a shoal in the river just off the wood station, which brought us up—bump, oh!—and there we stuck for an hour. The pilot, in awe of the captain's wrath, fled into the woods; and I afterwards saw him mount his mussick and ride off. After a time the steamer was got off, and the current, very strong here, spun her round, with her flats, at a marvellous rate, like a teetotum. After this, we pulled up at this station for the night.

November 23. Started again, and stuck again until the steamer was lightened, by putting what cargo she had, and her fuel, into the flats. Just as we began to get on again, smoke is observed down the river. A steamer sent with a party of surveyors for the Indus Valley projected line of railway is known to have left Kotree after we did, and it is supposed to be she. The vicinity of another vessel stimulates our crew, apparently, for we steam away at a greater speed to-day.

November 24. At daylight, up steam and away, our rival after us. At seven A.M. passed Mittenkote, now six or seven miles inland, but which last year the river washed so close, it used to be the station of the Punjaub Flotilla steamers. Here we turn eastward, entering the Chenaub River, which at this point joins the Indus. Navigation becomes now more intri-

cate, sand-banks more frequent, the current stronger, and the alligators larger. After breakfast, reached Chercha, five stations from Mooltan. Wooding here is performed very rapidly, the steamer astern stimulating every one to increased exertion. We are off again in a very short time; but it is quite plain, in spite of every effort, our friend astern is overtaking us; and when we stop for the night one of the river steamers passes, and makes fast close to us.

November 25. Very slow work; boat sent away sounding for the passages constantly. Reached Tibbee, the next station, as our rival left it. Wooded, and went on for Buckree. At night, an alarm, caused by a native deck passenger, who was sick, ending his sorrows by stepping quietly into the river in the dead of night, and drowning himself. Despatched a boat in vain to save him, the river sweeping by like a sluice. At Buckree the Sutlej joins the Chenaub; up the Sutlej to Ferozepore the water is shallower even than the Indus at this time of year, there being only about two feet six inches as a reliable depth.

November 27. Reached a narrow part of the river at Sultawgoshawur, only thirty-five miles from Mooltan; and here our steamer, our rival, and two others coming down stream from Mooltan, were all stuck at a dead-lock for some time. I began to despair, and sending for camels, made preparation to finish my journey in that way, when at last one of the steamers (our rival) was with difficulty got over the bad place, and ignominiously abandoning my vessel, I transferred myself to the rival; and on the 29th reached a part of the river's bank called Shershah, where there was a painted board announcing the Punjaub Railway premises, and where there was a house called a railway station; and, what was more, a railway for the rest of the twelve miles to Mooltan, which enabled me to finish my jaunt from Kurrachee to Mooltan in as comfortable a manner as could be expected.

Two facts strike me forcibly—the length of time occupied in doing six hundred miles, and the wonder that steamers can't be devised to go without barges, and still carry enough cargo to pay; and the other is the contrast between the country where there is water near, and where there is not. That the irrigation of India must be fairly considered as a question by which its future prosperity will be affected in no small degree, no man in his senses who has travelled through Sind and the Punjaub can deny. The point to decide appears to be, who is to do it?—whether it is to be left to the enterprise of the age, or whether the Government will undertake what must necessarily be more or less a Government work, under any circumstances.

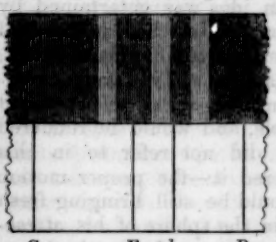
COMETARY LIGHT.—NEBULÆ.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

It is curious to remark the occasional revival, perhaps in a modified form, of speculations which have for a time been laid aside. At the period when much attention was drawn to the "Nebular Theory" of Laplace, and the condensation of luminous mists into blazing suns was commonly spoken of as the probable history of the universe, an idea was entertained by Sir W. Herschel that comets might be detached portions of nebulous matter attracted to our sun from the depths of space; and though his speculation was not announced in terms corresponding with the requirements of mathematical accuracy, yet it was in itself sufficiently remarkable, and would be rendered additionally probable by what he did not refer to in this instance, though he himself discovered it—the proper motion of the sun through space, which would be still bringing fresh portions of nebulous material within the sphere of his attraction. The doubt subsequently thrown upon Laplace's theory by the real or supposed resolution of certain nebulæ into stars with increased optical power, of course restored the comets to their independent rank. But the researches of later times, without giving countenance to Laplace's speculation—for the materials of the gaseous nebulæ do not appear capable of being condensed into suns like our own—have yet tended to re-establish the connection between these two most mysterious classes of bodies. Our readers are acquainted with the great fact that Huggins has obtained evidence of the gaseous nature of the nucleus of Tempel's comet (I. 1866); or at least of the identity of its constitution with that of the "planetary nebulæ" of H. This was the first precise intimation that had ever been obtained as to the real composition of these wandering members of our system. It is true that as a spectroscopic investigation it had been anticipated by Donati at Florence, in the case of Comet II. 1864, but his results are more equivocal, as he was less distinct in his interpretation of what he saw; nor could this be wondered at in any one who neither had the extraordinary experience of eye and hand which distinguishes our great observer, nor was previously aware of the peculiarity of the nebular spectra. At first Donati says that he perceived distinctly two dark bands in the comet's light; but he adds that the spectrum resembles that of the metals, the obscure being broader than the luminous spaces; and that it might be equally said to consist of three light bands. Hence, little more, indeed, could be inferred with safety than that it was elementary

and not reflected light, but even this was a long step in advance, and afforded great promise of future discovery. His very curious diagram is but little known in England, and we shall therefore give a reduced copy of it, which will be the more intelligible and interesting since, chiefly through the enterprise and perseverance of Mr. Browning, the spectroscope bids fair to become a more popular instrument amongst us; as it well deserves.

The uppermost portion of the diagram is the spectrum of the comet, exhibiting the three bright bands; the lower is the



corresponding portion of that of the sun, showing the four dark lines, and close groups of lines, named by Frauenhofer D *b* F and G; D, the "sodium-line," being to the right-hand. From this it appears that the light of the comet, being coincident with the blue and green spaces of the spectrum, must have had that hue. It may be presumed, however, that though this comet did not reflect solar light, in which case a more continuous spectrum would have been produced, yet its composition, however analogous, could not have been identical with that of our recent visitant. Mr. Huggins has spoken of the bright lines in the spectrum observed by him as resembling those of some of the nebulæ, and taking those of 37 $\frac{H}{9}$ IV. as a specimen (see INTELLECTUAL OBSERVER, vi. 402), we find their magnitude and arrangement very different, the whole of the nebular spectrum being comprised within the left-hand half of the space between *b* and F, and consisting of extremely narrow stripes, perhaps not exceeding one-fiftieth of the breadth of the bands in Donati's figure. Unless, therefore, there were some essential difference in the two instruments or modes of observation, it must be inferred that there was a wide dissimilarity in the composition of these two comets. This, of course, might have been expected. A very little attention to the descriptions of former comets would convince us that with complete identity of type there is considerable variety in detail; and some of these differences are such as to indicate diversity of materials, not merely as between different comets, but as co-existing in the same individual. One very remarkable feature of this kind is the combination of a straight with a curved tail; the one streaming right out into space, and piercing the ether, as it would seem, without resistance; the other swept backwards and condensed at its advancing edge, according to Kepler's striking comparison, like the corn in the winnowing-

floor. From such a division Bessel was led to the idea of a heterogeneous composition in 1807; and in 1858, though the pale thin narrow beam which preceded the grand flowing train of "the Donati" was totally missed in England, and found few spectators anywhere, yet its existence is too well established to admit of doubt, and inevitably leads to a similar conclusion.

Diversity of colour, too, points strongly in the same direction. This has always been a recognized peculiarity among comets; not only in ancient and less accurate, but in our own careful, modern days. Virgil's beautifully picturesque description—

> "liquida si quando nocte cometæ
> Sanguinei lugubre rubent,"

would lead us to suppose that since the epithets would hardly apply to the majority of cases, he must have witnessed some such portent of an unusually deep and fearful hue; and the Chinese record of Ma-tuon-lin, compiled in the thirteenth century, vague as it is in some respects, yet careful and precise in this, speaks not only of red, but white, blue, yellow, and violet comets. In our own times, no one who recollects the different aspect of the two great comets of 1858 and 1861 could doubt of the fact; while, as far as I can remember, the orange tint even of the last was exceeded by the very fiery and angry aspect of that of 1854, the sabre-like precursor of the Russian war. Even between the different parts of the same comet a curious difference of tint has been noticed. In 1811 Ⅰ remarked the very peculiar greenish or bluish-green colour of the head, while its central point had a pale ruddy tinge; and in 1858 the very feeble and wide-spread nebulosity surrounding the head was thought by Winnecke and Fearnley to be of a light-blue colour, while the head and tail were yellow. Here the reflected light, which was probably concerned, seems to speak sufficiently of diversity of material; but with the native light of the nucleus the case is still more evident, for spectrum-analysis teaches us that in all such instances a difference of colour, at least at corresponding temperatures, indicates the presence of a different element. We have no reason therefore for surprise at the contrast between the two spectra, one figured by Donati, the other described by Huggins.

In one respect, however, the comparison is not fully satisfactory. It does not appear how Donati's spectrum was obtained. Huggins, on the contrary, examined separately the nucleus and the coma, and hence possibly succeeded in obtaining more decisive evidence of its gaseous nature than can be deduced from Donati's figure. One great fact comes out in

both—the existence of elementary or unborrowed light. This indeed was nothing new; it had been maintained by Herschel and Schröter in 1807 and 1811, though subsequently discredited by other authorities. But the very curious distinction between the light of the central body and its envelope, though previously indicated by polarization experiments, was reserved to be demonstrated by the spectroscope of Huggins. Schröter, the strenuous assertor of electric light in comets, was so unsuspicious of this distinction that some of his chief proofs were drawn from the rapid changes and coruscations of the tail. On the other hand, Arago, the great advocate of reflected light, was somewhat less confident. His examination of the comet of 1819 with a doubly refracting prism showed two images of somewhat unequal intensity indicating polarization, and consequently reflected light; and at the return of Halley's comet in 1835 he obtained more decided evidence by the interchangeably red and green colours of the images in his polariscope, and thus he satisfied himself that the light of the body was not, at least in general, native, though he is very cautious in his conclusion, candidly admitting that the whole light might be partly intrinsic and partly reflected, since bodies becoming incandescent do not thereby lose the power of reflection. From this, however, it appears that he had less idea of the really native character of the light of the nucleus than of its becoming enkindled by its approach to the sun. In the same manner Bruhns at Berlin in 1858, and Murmann at the Vienna Observatory in 1862, found that the light of the great comets of those years, taken as a mass, was polarized, and therefore reflected.

In 1861 Secchi had obtained a better result from the magnificent apparition of that summer. He found the polarization of the tail and rays near the nucleus very strong, but no trace of it in the nucleus till July 3 and following days, when it presented decided indications of it, notwithstanding its very minute size (hardly 1″, July 7). This he thought a fact of great importance, as showing that the nucleus had possessed native light on the former days, being perhaps rendered incandescent in its perihelion. The following year brought us a less brilliant but curiously developed comet, which has been described at length in one of our earlier volumes, and in this again he could detect no polarization in the nucleus, except a feeble trace on the last day of observation, while the aigrettes, or jets, unpolarized at their origin, became more so as they passed into the strongly polarized condition of the surrounding nebulosity. Non-polarization, however, is no conclusive evidence of native light, though polarization is a test of reflection; and hence Secchi supposed that the nucleus and aigrettes, if not incandescent, which he thought a less probable

idea, might consist of vapour in a vesicular state, like our clouds, which do not polarize, while the coma and tail were in a gaseous and polarizing condition. Huggins, however, by his more refined and critical mode of analysis, may be considered to have decided this question. An important remark of his should not be omitted here. He thinks that the dark spaces which so frequently intervene between the multiple envelopes of comets, may represent an intermediate condition of the matter originally derived from the nucleus, when it has ceased to be self luminous, but, from still retaining its gaseous state, is capable of reflecting but little light in its transition to a more visible condition, analogous to fog or cloud. Many curious questions of detail, however, remain to be considered, and it is to be hoped that before long the near approach of some magnificent and fully-developed comet, such as that of 1744, which nearly rivalled the splendour of Venus, and was visible to the naked eye at noon-day, may give full scope to the employment of his extraordinary means of investigation. Even before the arrival of such a phenomenon, some out of the ordinary profusion of smaller comets may furnish materials for keeping us on the alert. Eight of them, of very various sizes, were recorded in 1858, and the recent scarcity may be fairly considered the precursor of renewed abundance.

The comet whose light Huggins so successfully analysed, though not a brilliant, is in some respects a remarkable one. D'Arrest observes that it is the sole instance hitherto known of retrograde motion combined with shortness of period. The latter he fixes at $3930\frac{1}{3}$ days, the course all lying within the orbit of Saturn. Pechyle has given 53 years, Oppolzer about 30, but D'Arrest considers the elements very uncertain. At its first discovery, by Tempel, its motion was so rapid that it passed in 5h. through 2°, or about four times the breadth of the moon. D'Arrest remarks that its present orbit may be of modern date, and that it is more and more probable that comets of short period have not long pertained to our system, and are rapidly tending to dissolution. This he thinks is indicated by the unquestionably decreasing brilliancy of Encke's and Faye's comets, and notices Kepler's anticipated description of the fate of that of Biela, when he suggests the possibility of their division and dissipation.

The total loss, as it would seem, of the latter comet, though not an unprecedented occurrence, as that of 1770 never appeared again according to computation, is an event of considerable significance. It is an additional proof that the stamp of mutability has been impressed upon all created matter. From the comparatively small dimensions of its orbit, and the known character of the space which it had to traverse and the

perturbations which it would undergo, such a termination was not to be foreseen. But, considering the multitude of minor planets (now amounting to 89), and the probability that their number is by no means exhausted, there is no extravagance in the supposition that it may have encountered some such member of our system, and may thus have changed alike its mode of existence and of motion; destroyed, possibly, in the ordinary sense of the word, but, in the design of an omniscient and omnipotent Creator, merely transmuted into some newer form, not less valuable in itself, nor less conducive to the well-being of the great whole.

NEBULÆ.

We will proceed to some additional details on the subject of nebulæ, which could not be included in our former paper.

Up to October, 1864, Prof. D'Arrest had carried on the Copenhagen Review of Nebulæ, begun in the autumn of 1861, to upwards of 2500 objects, and looked forward to its completion after a year or two more. Of his 215 new nebulæ, a few, he found, had been anticipated by H and the E. of Rosse. 32 out of them he classes as B(right), though generally recurring as F(aint) in some of his revisions. 3 are of H's first class. He speaks of 2 great groups of Nebulæ in R. A. 11h. 58m. D. N. 21°, and R. A. 12h. 53m. to 56m. D. N. 28° to 29° (in *Coma Berenices*), neither of which had then been investigated by Lord Rosse, where, under particularly favourable circumstances, he has seen an extraordinary number of unknown nebulæ. They are, especially in the second group, "incredibly numerous and crowded, and, though extremely small, of a diversity of which no idea could have *a priori* been formed. Occasionally, in the most favourable moments, I have had the very exact impression, as though the nebulæ, often containing only a few seconds in diameter, though intermixed with larger ones—round, longish, stellar, or comet-like—lay packed together like oysters in a barrel."

Of Rosse's 35 "nebulæ not found," D'Arrest had seen 12, and confirmed the invisibility of 4 others. He had repeatedly seen that most curious object, 55 *Andromedæ* (INTELLECTUAL OBSERVER, vi. 448) quite clear of nebulosity subsequently to Aug. 1862; and, still later, Huggins had found its spectrum similar to that of other stars. "This instance," says D'Arrest, "is one of the few which deserve especial attention in future." It will be readily found a little way *sp* γ, being of 5½ mag., and the nearest star of that magnitude in that direction.

He has given a catalogue, up to the beginning of 1861, of 50 of those most singular and suggestive objects, Double Nebulæ, including about $\frac{1}{5}$ of the whole number visible with

the Copenhagen telescope. Of these 11 or 13 are new. On his No. 1—R. A. 8° 2′ (*not* 8h. 2m) D. N. 0° 2′, both equally bright, *p* longish, *f* round, distant 3′, he remarks, "What has been observed in this place by W. and J. Herschel and by Bond, cannot be brought into sufficient accordance either with one another, or with the existing sky. It is triple." He thinks proper motion possible in 2 members of a triple group; R. A. 137° 50′, D. N. 34° 19′.—113 H. I. H. 581. (These, however, are not identical in Gen. Cat.—582 may be meant, but the locality is very puzzling.)

The interesting question of Variable Light still continues to attract attention, as well it may. Of the 3 supposed variable nebulæ in *Taurus*, we have recently heard very little. Hind's was just caught with Mr. Gurney Barclay's 10 inch achromatic at Leyton, in the winter of 1863-4. I am inclined to think that the nebula in the *Pleiades* (No. 6 of our list) is fainter than it was in 1863-4. In looking for it with 5·5 inches of aperture, on a transparent night, 1866, Feb. 12, I could scarcely perceive it with a power of 30 or 65, while the eye was in in its usual position, or turned sideways to the left, but when twisted sideways to the right, in one of those contortions to which the possessors of achromatics are occasionally subjected, I saw its *f* border—or thought I saw it—distinctly crossing the field of 65, just like the edge of a faint comet's tail. Possibly it may be found that a varied position of the eye may be of use in detecting extremely faint phenomena. The lovers of scenery well know how curious and beautiful an effect is produced upon a landscape by viewing it with the head inclined to one side.

D'Arrest had previously remarked how singular it was that 3 variable nebulæ should be found only 9° and 8° respectively apart, and in a portion of the sky where nebulæ are rare; all of them becoming invisible, or nearly so, about the same time. Contrary to his idea that the list of such objects was nearly exhausted, a fourth has since been added to it, and, strange to say, in the same region. In April, 1863, Chacornac perceived a nebula a few minutes of arc distant from ζ *Tauri*; in Sept. it had become invisible in the achromatic at Copenhagen. And now that the fact of variation may be considered established, and does not rest upon a solitary or doubted instance, older observations and drawings, as our authority remarks, acquire an importance which would by no means have been accorded to them a few years ago. Other suspicious cases have been mentioned. Schmidt, at Athens, had recorded, in 1864, 4 nebulæ surrounding M. 49 (G. C. 3021, R. A. 12h. 22m. 39s. N. P. D. 81° 13′ 44″). They were extremely small and faint, even in his lovely sky. This, unfortunately, is no

matter of surprise, as he informs us that his dialyte is so injured by the deterioration of its polish, that it may be considered "a wholly ruined instrument;" an announcement which all lovers of astronomy will hear with sincere regret, and earnestly wish that so diligent an observer may soon be armed with a larger achromatic of English glass, which is not subject to decomposition, or with one of the silvered reflectors which are now attaining such perfection. On the contrary, D'Arrest found 3 of these nebulæ bright and pretty large, but one decidedly invisible at Copenhagen, and only 2 minute stars in its place. This struck him the more, as he could see without the smallest difficulty a feeble nebula, which neither Schmidt nor any one else had perceived except its discoverer, Struve II. It is singular, too, that ♅, in 1785, had pointed out a faint nebula (498 ♅ II.) very near the site of Schmidt's missing object, which, as nothing could subsequently be found there, was supposed to be a mistaken double entry of 18 ♅ II.

Rümker, at Hamburgh, with nothing more than a 5ft. achromatic, found that 68 ♅ IV. (G. C. 1888), R. A. 9h. 32m. 18s. N. P. D. 30° 31′ 15″, instead of being, as ♅ called it, "considerably faint, very small," might be better described as "very bright, large," and he remarked, on two occasions, that a companion star, 11·2 mag., seemed surrounded with faint nebulosity.

We must return to this subject at a future opportunity.

OCCULTATIONS.

Nov. 11, B. A. C. 6287, 6 mag. 5h. 7m. to 5h. 23m. B. A. C. 6292, 6 mag. 5h. 16m. to 6h. 31m. (This will be a noteworthy observation, from the near coincidence of the immersions. The conditions also will be favourable, the moon being a crescent, 5¼ d. old).—12th, ρ^1 Sagittarii, 4 mag. 5h. 22m. to 6h. 34m.—14th, 9 Aquarii, 6 mag. 5h. 9m. to 5h. 45m.—15th, B. A. C. 7620, 6 mag. 6h. 12m. to 7h. 26m.—16th, 67 Aquarii, 6 mag. 5h. 16m. to 6h. 19m.—20th, ξ Arietis, 5½ mag. 6h. 58m. to 7h. 58m. B.A.C. 755, 6 mag. 7h. 48m. to 8h. 50m.—22nd, 75 Tauri, 6 mag. 6h. 43m. to 7h. 38m. B.A.C. 1391, 5 mag. 7h. 39m. to 8h. 15m. *a* Tauri, 1 mag. 9h. 58m. to 10h. 52m. (But for the nearly full moon, a night of especial interest: it also includes a near appulse to θ^1 Tauri, 4½ mag. at 7h. 8m.)—24th, 26 Geminorum, 5½ mag. 9h. 29m. to 9h. 57m.—27th, o Leonis, 3½ mag. 11h. 13m. to 12h. 9m. (The reader will be struck with the curious *run* of the hour-numbers in this unusually full list.)

WILD KAFFIR LIFE AND WILD KAFFIR INTELLIGENCE.

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At page 188 of the October number of the INTELLECTUAL OBSERVER it is stated that the 10,000 "Natal Kaffirs" of 1836 have grown into 200,000 Natal Kaffirs in 1866; and the inference is drawn that the native race in that colony is increasing in numbers rapidly, and not dwindling away, under the presence of British enterprise and rule, and that therefore the question of the capabilities of that race is an important one. It may be necessary to explain that the Natal Kaffirs thus alluded to were Kaffirs who acknowledged English authority, and came within the sphere of civilized observation at even that early period, or very soon afterwards. The Kaffirs spoken of by Mr. Fynn as "Natal Kaffirs" were natives who had gathered round his settlements at the Bay. The rapid increase in numbers was, in all probability, due to the addition of more and more resident clans to the white man's following, as well as to the return of exiles, and the influx of refugees. The Secretary for Native Affairs in Natal has recently ascertained by direct investigation, that there are at the present time forty-three distinct clans, or tribes, within the colony, which were aboriginal tribes of the district, and which have never dwelt elsewhere, excepting for any brief period that they may have been compelled to remove themselves into concealment during the Zulu invasion and occupation. There are also twenty-two other native tribes in Natal, of which nine are composite and made up of a fusion of the fragments of aboriginal tribes, and of which seven are Zulu tribes which have removed themselves from the territory that is still under Zulu rule.

Before the rise of the Zulu power these aboriginals were neither warlike, nor aggressive. Disputes occasionally arose, both between families and between tribes; but such disputes were always speedily settled. There was no attempt at military organization. The several tribes were, for the most part, on friendly terms, and intermarried with each other. They possessed cattle, sheep, and goats; and cultivated the ground, and drew the principal portion of their subsistence from their gardens. They were, indeed, to a considerable extent what the Natal Kaffirs are now seen to be in the colony. The notion of Zulu-Kaffir ferocity, which has become

prevalent in late years, does not properly belong to these people. It has come from an accident in their history; the development of the Zulu military despotism under Chaka, which has been already described.

The chiefs of these aboriginal tribes ruled as patriarchs, and possessed absolute and uncontrolled power over the lives and property of their people. There was no other check to this irresponsible power than that which arose from the necessity, even in this state of affairs, of conciliating public opinion.

At the present time the several chiefs of the sixty-five tribes of Natal Kaffirs retain only the shadow of their old authority. They are allowed to settle disputes between their people, and to punish petty offences, but all criminal cases are now tried by the magistrates and the Supreme Court of the Colony; and even in cases adjudicated by the chiefs, an appeal can be made to the magistrates, to the Secretary for Native Affairs, and to the Lieutenant-Governor in Council. All supreme power has been transferred from the petty chief to the proper head of the State; and the chiefs now only consider themselves lieutenants, responsible to the Governor for the management of their tribes. They can no longer assemble their people in arms, unless under the order of the Governor. The attempt has been made, and with a considerable measure of success, in Natal, to turn the natural and inherent sentiment of respect for the patriarchal chiefs into a means of orderly government. By leaving a show of authority, and a harmless jurisdiction in the hands of the chief, his dignity has been saved from the evil effects of rude shock, while, at the same time, he has been made the direct link which connects his people with the institutions of the Government. The tribes themselves are divided into territorial districts, villages or kraals, and families. The chief presides over the tribe with a head-man, or Induna, under his authority. Each territorial division of the tribe has also its own proper head-man, or Induna; and there are also heads of groups of kraals, heads of kraals, and heads of families. Each head is practically responsible to the one immediately above him; and in the ascending series the chief of the tribe is responsible to the resident magistrate of his county; and the magistrate to the Secretary for Native Affairs, who is the head-man, or Induna, of the Governor, *par excellence, the* great chief. This organization is so complete, that any order emanating from the Governor can be at once made known to every native hut in the land, although the communication has necessarily to be made without the intervention of written or printed documents.

The huts of the native Kaffirs are nearly always grouped

together into villages, which are technically named "kraals." The huts are planted upon sloping ground, whence the water can run away easily, and are ranged in circles larger, or smaller, according to the number that has to be accommodated. The head of an ordinary family will have perhaps from six to ten huts in his kraal. The chief Ngoza's kraal near Table Mountain, to which the hut of the Tinted Plate at page 185 belongs, has some eighty or ninety huts in it, and is a pretty long walk across. Old Umpanda has a royal kraal at Nodwengu in Zululand, containing six hundred huts arranged round the circle in triple ranks. The huts are fenced in with stakes and wattle, which thus form an outer wall to the kraal. But there is also within the circles of huts, an inner wall of similar construction, which encloses a kind of court-yard, that is entered by a single opening, and that is employed for herding cattle at night. The huts thus stand in a clear, ring-shaped enclosure of their own. The interior space of the kraal of Ngoza, to which the hut of the Tinted Plate belongs, is so spacious, that upon one occasion, when it contained the wagons and travelling oxen of the writer, and of the Lieutenant-Governor, with the tents of their encampment, in addition to the very large herd of oxen belonging to the chief, it still looked like a large and nearly empty field.

A very good idea of the appearance and size of the Kaffir hut may be gleaned from the plate, where Ngoza and his men are seen at the back of his own immediate dwelling. This structure is not very unlike a squat bee-hive, large enough to hold men, instead of insects. It is unquestionably a rude affair, when compared with the dwellings of an older and higher civilization. But there is another point of view from which it may be contemplated. Taken as a structure made almost out of nothing, by hands that are almost innocent of instruments, it is really a surprisingly ingenious and complete contrivance. In order fairly to understand this, the reader must conceive a man, just in the state in which nature has made him, planted down on a piece of wild pasture, with nothing but a rudely-fashioned lance in his hand, and told that he must fabricate there for himself a structure that shall at once be both clothing and house, and that shall efficiently shelter him through day and night, through storm and sunshine, through summer and winter. If the reader himself could be made the actual hero of the situation, he would be better able to comprehend what the task is that the wild Kaffir has accomplished, when he has made this straw house, than he can be without the experience. In constructing the hut a frame-work of wattle is first bent into a hemispherical shape. A thatching of dried grass is then laid over the

wattle, and bound compactly down upon it by fibres. A low arched door, very much like the bee's door, is left at one point, through which passage is made horizontally, either for ingress or egress. The correct position is something even more abject than that which is familiarly known as on all fours. This doorway is closed at night by a frame of wicker-work. The floor is a smooth, hard, and almost polished pavement, constructed of beaten earth and cow-dung. If the hut is of large dimensions, it has four or six posts inside; but if of small size, these internal supports are not used. There is a saucer-like and rimmed depression in the middle of the floor, to serve as a hearth in cold weather, and the smoke and air permeate the grass with just sufficient freedom to secure ventilation, but not one drop of water enters from the sky. Round the walls, in the interior, the scanty Lares and Penates of the master, consisting principally of beer pots, milk pots, mats, skins, and shields and assegais, are distributed. Upon the floor with rush mats unrolled beneath them, the dusky household squat to gossip by day, and lie outstretched to sleep at night. Each hut affords sleeping-room for several individuals. The chief, or head-man of a kraal has a principal hut for himself, where his visitors come to gossip and feast with him, and also a hut for each of his many wives, whose families dwell therein with them until the children attain a certain age. In most kraals there is also a hut set apart for the use of young men.

The Kaffir is eminently a creature of sunshine. In cold or wet weather he keeps himself close within the shelter of his hut, and gossips and doses away his time. When the sunshine is genial and warm he sits outside squatting upon the ground, surrounded by his dogs and his children, and fashioning some article for household use, for employment as a weapon, or for personal adornment; or with a small shield upon his arm, and a bundle of short light assegais, and a knob-headed stick in his hand, he strides off over the hills bent upon some business of gossiping or feasting. The cattle are principally tended and herded by the young boys, roaming free over the pastures by day, and being driven into the inner enclosure of the kraal for protection at night. In some convenient nook on a hill side, or in a sheltered ravine near to the kraal, a space is rudely fenced in as a garden, and here crops of the Indian corn, the millet, the sweet potato, and occasionally of the pumpkin, a wild sugar-cane (Impheè), and wild hemp, and tobacco for smoking, are grown. The ground of the garden is broken and tilled by the women, working with a curious kind of hoe, now imported largely into Kaffir lands for native use. The Indian corn and millet are produced in large quantities, and ordinarily form the staple of a Kaffir's food. The grain is stored, after

harvesting, in pits dug in the ground, with only a narrow opening left at the top, which is carefully and skilfully closed by placing a flat stone over it, for protection against the rain. The food is prepared by the women, sometimes aided by the children and young lads. The Indian corn is roasted, when green, upon the cob; when ripe the grain is crushed by hand, between stones, and the meal converted into a kind of porridge. The milk from the cows is chiefly consumed in a half sour and clotted state by the children. The millet is ground between stones, and made into a sort of infusion or decoction, which undergoes spontaneous fermentation, and so becomes converted into a liquor that is known as Kaffir beer (Tywala). In its choicest state, as it is found in the cellars of distinguished men, this liquid is limpid and clear, and possessed of considerable inebriating power. It is unquestionably very nourishing. In more common-place households it bears a considerable resemblance to a mixture of bad gruel and table beer. The beer drinking is the most ordinary form of native carouse. When there is a good brewing ripe, the men assemble and drink the liquid in rotation out of capacious gourds or pots, made of closely and thickly-woven grass, or more rarely of hardened clay. The beer is kept during fermentation in these vessels, which stand in the interior of the hut, opposite to the doors, something like the jars of the Forty Thieves, in a long row. The milk is held in similar vessels. The beer pots and milk pots are carried by the women and girls, very skilfully balanced upon their heads. A jovial spark, off on a visit, may be sometimes met, with a string of women or girls, each with a full beer pot balanced on her head, behind him. The water for household use is brought in by the women from the nearest stream, in gourds.

Under ordinary circumstances the gardens furnish a fairly ample supply of food for the daily wants of the household. But occasionally from some accident of season, or from some other cause, the supply runs short, and periods of great privation have to be endured. One of the first benefits which the barbarian reaps from the neighbourhood of civilized men is the alleviation of this unavoidable misery of barbarous life. So soon as he has white neighbours within reach of his kraal, he is pretty sure to have some additional resource to draw upon in seasons of dearth and famine. In olden times, and still in remote districts, the Kaffirs occasionally die of famine in great numbers; and those who survive subsist to a large extent, even for weeks at a time, upon wild roots dug up out of the ground.

Animal food, among the Kaffirs, is entirely a matter of carouse and feasting. If a distinguished visitor comes to a

Kaffir village, or kraal, the principal man makes a present to the visitor of a goat, or of an ox, as the case may be. The animal is graciously received, and turned over to the attendants of the guest for slaughter: some choice part is retained by the guest, and the rest is handed over to the inhabitants of the kraal, to be eaten in honour of the visit. Animals are also killed and eaten upon certain other ceremonial occasions, when set invitations are given, and set feasts made. Upon such occasions, if it is an ox that is to be eaten, it is taken near to the entrance of the kraal, and stabbed behind the shoulder with an assegai, wielded by some expert hand. A fire is kindled near, and almost before the animal is dead it is hewn to pieces, and the selected portions being removed, the rest is divided in what seems to the uninitiated observer to be a sort of scramble; but it is in a scramble that has in itself some underlying order of accepted etiquette and custom. The fragments of meat are just laid for a brief interval upon the embers of a wood fire that has been prepared close at hand, and are then rapidly transferred to the throats and stomachs of the feasters. The eagerness for the unusual, and rare, gorge is far too keen to allow any refinement of culinary art to be either learned or exercised. A couple of hours is pretty well enough, in Kaffir handling, for the conversion of a living ox into a remnant of stripped skin and bare bones.

Well-to-do Kaffirs rejoice in a multiplicity of households. In the kraal of a chief, or of a wealthy patriarch, each hut near to his own, contains a wife, and that wife's offspring, and the more distant huts are appropriated to the other members of the family or clan. Polygamy is an institution among the Kaffirs, that is intimately and inseparably interwoven with the privileges of wealth and the rights of property, and that will therefore be very difficult to eradicate. The Kaffir has strong natural instincts of affection for his wives and his children, as a rule; but the peculiar position which he holds as a polygamist, of necessity introduces some relations and characteristics into his domestic life and social history that are not calculated to awaken interest or respect. In all probability some of the incidents and occurrences that arise out of these relations are but imperfectly understood by European censors and critics. Kaffir men do not acquire wives until they are able to pay a stipulated number of cows to the father of the bride for the privilege. These cows are differently viewed by the different authorities who speak of Kaffir practices and customs. By some they are held to be an actual purchase price paid for the girl. By others they are considered to be a sort of deposit made in her interest to her family. In case of a wife leaving her husband within a limited period, he is allowed to have some

claim against her parents for cow-restitution; but matters are held to be in some way changed when she has bestowed female offspring upon her husband. In some instances a family of girls confers a measure of freedom and independence upon the mother, because the value of the cows, price or deposit, is thus restored. At any rate the women are looked upon as possessing material and substantial value in a household, because they bring girls, who in due time turn into cows; and because they perform hard and productive drudgery. The children of any particular wife speak in common of all the other wives of their paternal parent as "mothers;" and, as a general rule, there is a surprising amount of harmony maintained in the household under the circumstances. According to the old and time-honoured custom of the Kaffirs the father's property in his daughters was so absolute and complete, that his sole will determined all matrimonial arrangements, and he possessed, and not unfrequently exercised, the right of punishing a refractory child who refused to obey his commands with death. Since the subjection of the Kaffir chiefs to British supremacy and rule, all coercion of girls to an unacceptable marriage has been generally forbidden, and in any case where an appeal is made against parental authority upon this ground, the magistrates discountenance, and even punish, its exercise. It is the intention of the colonial government, at the earliest possible opportunity, to introduce some arrangement which shall make a full and clear declaration of a woman's personal consent indispensable to the legality of a native marriage. In the meantime two very important alterations in the old Kaffir practice have already been brought about. Every marriage now consummated is held to be irrevocable and final, so far as the parents of the woman are concerned; and a widow is now free to marry any one that pleases her without reference to the opinion or will of her natural guardian. These important modifications have been made by the Lieutenant-Governer, acting in his capacity of supreme chief, and have received the general assent of the natives on the ground that they admit them to be just and reasonable. It is obvious that some caution and judgment is required in the introduction of changes that are directly aimed at the root of a practice which is intimately bound up with the customs, habits, ideas, and laws of a race, and which the people believe to have been created with them.

Mr. Crawfurd considers the negro to be a very unmanageable and unpromising piece of humanity. He remarks of him that he has no literature, and no architecture; that he cannot tame elephants; that his religion is nothing but witchcraft, his wars merely the incursions of savages, and his government only a brutalized despotism. Without at present meddling with the

inferences which Mr. Crawfurd draws, it must be admitted here that these allegations apply as accurately to the Kaffir as they do to the pure negro. It is a very remarkable fact in human history, that the Kaffir, with such inherent capabilities, should have remained utterly savage so long; that even, after seeing with his own eyes the wonders that are worked by his white cousins, in matters that come so immediately home to him, as flocks, herds, and food crops, he should still be willing, if left alone, to lead the indolent, unproductive, and unprogressive life that has been described. Whatever may be the case in regard to the principle that Sir S. W. Baker enunciated so prominently at the last meeting of the British Association for the Advancement of Science, namely, that all negro races would infallibly fall back into barbarism, if left to themselves; there can be no doubt, at any rate, that these races will not advance out of barbarism, if so left. But here there occurs one consideration, that perhaps has not yet received all the attention it deserves, and that really carries with it much important and practical suggestion. Mr. Crawfurd argues, "The negroes are uncivilizable, or nearly so, for, after years of social existence, they have no literature." May it not be that the negro races have not advanced into civilization *because* they have no literature? A race which is incapable of originating a literature, may, nevertheless, be quite capable of being deeply and permanently influenced by a literature that is brought to them from without. This literature may indeed ultimately prove to be the very panacea and influence that makes progress possible and advance permanent. It is by no means an unheard of thing in human history, that races have received and benefited by a written and recorded language, although they had failed to contrive the instrument for themselves.

It is a very curious, and certainly a most noteworthy fact, bearing indirectly but instructively upon this view, that the wild Kaffir, even when quite removed from the influence of white men, and from civilized appliances and practices, has, nevertheless, *an education* of his own. This becomes strikingly apparent to even the most careless and most casual observer, when the young men and the old men of the race are compared. The young men are all wild, impulsive, restless, and full of savage fire, which generally burns itself out in howling, dancing, boasting, and laughing, but which is quite capable, as proved in Chaka's experience, of being turned to less desirable account. The old men are all quiet, astute, thoughtful, and full of "wise saws and instances." The countenances of the young men are commonly savage and furtive, even when good humoured. The countenances of the old men are constantly dignified, grave, and intelligent. In Zululand, at this

present hour, the young men are nearly all turbulent, quarrelsome, boastful, and aggressive; the old men are nearly all quiet, peaceful, and full of admiration and friendship for their Dutch and English neighbours. There is a very simple and obvious reason for this difference. The young men are all of the raw material of barbarism; the old men are all *educated!* The education of the Kaffir race is talk. The remark of Sir S. W. Baker and others, that the negroes acquire their full intellectual development at a very early period, and are incapable of subsequent advance, certainly is not true in regard to the Natal Kaffirs.* The wild Kaffir leads a life of indolence, and puts the amount of drudgery that is requisite to provide for the absolute essentials of this indolent life upon his women. But he also leads a life of *gossip;* he talks incessantly, and much of his talk concerns the doings of his relatives and neighbours, and the general relations of his social state. When he walks forth over the sunny hills to pay his visit to some neighbouring or distant kraal, he carries with him matters that have to be made there the theme of patient discussion and grave deliberation. It is not possible for men to gossip through long years without doing some thinking as well, and, wherever there is thinking, there is also intellect and progress. But, in the case of the wild Kaffir, the progress is individual, and not collective. Each man has to go through the same process for himself, and the result dies when the man dies. Tradition may carry on some very small shadow of the sum total and gain to the next generation, but the main bulk of the personal advancement and experience must disappear. And can it be said that it would not be the same, even in England, if there were no permanent and recorded accumulation to be transferred on from generation to generation? if there were no books and no formal teaching? Men may say that the negro races cannot be raised much, or at all, above their present stand points, and they may be right; but, at any rate, an appeal necessarily lies from such judgments to events and time; and, not until it has been seen what the modifications are, that a formal, a designed, and a well considered training and education can introduce, can the question of Kaffir civilization be held to have received a practical settlement. It yet remains to state, indeed, that something has already been actually achieved in Natal, which does give promise of a higher capability in the native race than the theory of unprogressive stagnation and ready retrogression would allow. This is reserved for another opportunity.

* There is no satisfactory ground for believing it true of the negro. The balance of evidence is on the other side.—Ed.

AIDS TO MICROSCOPIC INQUIRY.—No. VIII.

Organic Substances and Formations.

In a former paper of this series, entitled *Notes on Organic Chemistry*, vol. vi. p. 428, some illustrations were given of the general principles upon which the elements of living bodies are combined, and we shall now consider the nature of some of the principal substances found in organic beings.

It astonishes a pretty young lady to tell her that, chemically, she consists of a pail of water, a few gases, some charcoal, lime, iron, phosphorus, and a few et ceteras; but the statement is, nevertheless, very near the truth. Organized beings are composed of very similar materials whatever may be their zoological rank, and they do not differ so much from vegetables in mere composition as was formerly supposed. They contain, for the most part, hard structures and soft ones—the former being for supports, frame-work, etc., and the latter constituting the more vital portions. In man, the hardest material is the enamel of his teeth, and among the softest are his nerves and brains. Human bones, and bones in general, are composed of a soft material, which when extracted from them is known as *gelatin*, and a hard one strengthening the former, consisting almost entirely of phosphate of lime. It is interesting to compare a hard firm bone of one of the higher vertebrates with the soft bones of cartilaginous fishes, sharks, etc., the magnates of the fish world, whose elevated position is demonstrated to the satisfaction of naturalists by their superior power of devouring their brethren, to which end they are elaborately organized. A terrestrial beast of prey with the soft bones of the shark would not be a successful animal, and should any morbid condition turn out a lion as a gristly monster, "Natural Selection" would take no steps for his preservation, but his days would be soon finished in the stomach of a more earthy-boned brute. In the water, things are different, and the lightness of the shark bone more than compensates for its slighter strength, while its pliability is no doubt convenient.

The combination of phosphorus, a soft highly combustible solid, of oxygen, the gas that gives its life and fire-sustaining qualities to atmospheric air, and of lime the well-known earthy mineral, results in *phosphate of lime*, to which bones owe their hardness and solidity; and which meets us again as one of the constituents of wheat flour, and many other substances used as food. The animal derives his phosphates from the vegetable, and when the animal has done with them, and

passes them away in secretions, or lays them down with his bones to rest in their mother earth, fresh plants catch them up again, and bring them once more within the circle of organic life.

The simplest animals are composed wholly or chiefly of *sarcode*, the soft stuff of which the infusoria are made, and which with a little modification constitutes the bodies of the polyps. As it occurs so commonly as a chief constituent of the lower kinds of animals in their adult form, it is not surprising that it is found in the larval or embryonic stages of higher ones, including man himself. One of the best ways of getting a notion of the appearance and properties of *sarcode* is to look at an *amœba* through a microscope. Chemically it has a close relation to the muscular tissues of higher animals, as it belongs to the *proteic*, or *albumenoid* group of bodies. The principal substances composing albumen, the type of this group, are, carbon, hydrogen, oxygen, and nitrogen, but small quantities of sulphur, and some saline ingredients are always present. Albumen is easily studied in its well-known form, white of egg. Albumen, and its near relative *fibrin*, can exist in two conditions, soluble and insoluble. The white of egg readily coagulates on the application of heat, and fibrin, which the blood holds in solution coagulates on being withdrawn from the vessels of a living animal. Substances closely resembling, or identical with albumen and fibrin, exist in the vegetable world, and especially in seeds, which are found useful for food. The albumenoid group are essential to animal life, and probably to organic life, though their quantity in many plants may be infinitesimal, and they are remarkable for the facility with which they undergo chemical changes. They give its chief nutritive value to milk, to the meal of peas, beans, and other bodies standing high as food.

As the object of the present paper is solely to help beginners and those who are not special students of chemistry, we shall not introduce any of the complicated questions relating to the chemistry of the constituents of animal bodies, but add a few words on some important compounds, beginning with *muscular tissue*. It consists chiefly of coagulated fibrin, "but being highly vascular, and containing nearly three-fourths of its weight of water, it is permeated with a fluid consisting partly of blood and partly of substances secreted from it, independently of a small portion of nervous and adipose matter."*

The portion of muscle which is soluble in cold water consists of albumen, salts of the blood, and two crystallizable animal principles named *kreatine* and *inosite*, several acids, and

* Prof. Miller's *Elements Chem.*

a peculiar red colouring matter. All kinds of flesh contain an immense quantity of water, and unless the chief animal tissues and substances are very moist, active life appears impossible, though some creatures may be very nearly dried without being killed. In such a condition they are torpid, from suspended functions. By drying animal substances their susceptibility to chemical change is destroyed, as is illustrated by the fact that in some parts of the Andes, and in other very dry, cold places, the bodies of the dead shrink into natural mummies, and suffer no decay.

Ready susceptibility of chemical change is the condition of those substances on which life mainly depends, and the nerve materials exhibit this quality in a high degree. The human brain contains in one hundred parts, about seven of albumen,* five of peculiar fatty acids—one of which, cerebric acid, contains phosphorus—and about eighty of water. Cerebric acid contains no less than five bodies, carbon, hydrogen, nitrogen, phosphorus, and oxygen, and many other important animal compounds are equally complicated. As might be expected from the complex character of the substances we have mentioned, blood, from which they all spring, is remarkable for its numerous and complicated components. Chemists recognize in it four kinds of fatty matter, fibrin, albumen, common salt, and other soluble salts, together with other materials, amongst which iron is conspicuous. We have seen that the chemical composition of animals and vegetables is substantially the same, but the proportion of the various compounds entering into both, vary very much, the animal series being remarkable for the quantity of their highly complex nitrogenous elements, while the hydro-carbons with oxygen prevail in plants. A comparison of fibrin with wood may be interesting and instructive. The former contains more than half its weight of carbon, about 6 per cent. of hydrogen, about 15 per cent. of nitrogen, about 23 per cent. of oxygen, and small quantities of sulphur and phosphorus. The latter varies a little according to its kind, but a piece of oak will contain about 49 per cent. of carbon, about 6 per cent. of hydrogen, about 43 or 44 per cent. of oxygen, and, in some cases, a little nitrogen, say 2 per cent.

The essential part of wood is its fibre, called in chemical language *cellulose*. This contains 36 definite portions of carbon, united to 30 definite portions of oxygen, and as many of hydrogen. In a very delicate form, cellulose is digestible and nutritious, but as soon as it concreted into firm fibres like hemp, cotton, etc., it is no longer fit for the food of human beings.

* See Miller.

The horse can digest cellulose in a more compact form than man, the camel perhaps still more so, and certain wood-devouring insects possess additional faculties of the same sort. A clean cotton fibre is nearly pure cellulose, and so is that elegant material erroneously called "rice paper," and made by the Chinese from the pith of the *Aralia papyrifera*.

The hair, hoofs, horns, and feathers of animals are very similar in chemical composition, and silk is very like them, and belongs to the same series. Speaking generally, we may say that these substances are rather more than half carbon, about one quarter oxygen, about a sixth nitrogen, and they contain about 3 per cent. of sulphur.

The solid parts of insects, such as the elytra and hard skin of beetles, their jaws, ovipositors, etc., and the shells of certain rotifers, etc., are composed of *chitin*, a substance chemically resembling the preceding, but with a larger allowance of oxygen. This substance is also found in the organic matter of the shells of crustaceans—those of water fleas (*Entomostracea*), for example, contain little else.

Professor Miller says "sugar appears to be the basis or foundation of organic matter in general, and from it all the varieties of organized products might be obtained by the addition or subtraction of water, oxygen, and ammonia."* This is cited not to convey the impression that all organic bodies do actually arise out of such a mode of treating sugar, but to illustrate the relation which different organic compounds bear to each other.

Organic compounds placed under appropriate conditions are susceptible of endless changes and modifications, first by simple addition of definite quantities of materials they already possess; secondly, by removals of certain constituents, wholly or partially, but always in definite proportions; thirdly, by *substitution*, that is, by taking away certain elements in definite proportions, and adding new elements in *equivalent* proportions. Living beings take matter into their system in one condition, and change it by processes of this kind. The plant is remarkable for the extent to which it can convert inorganic matter into organized combinations, and the animal with some power of this sort is chiefly occupied in receiving from plants, or from other animals, materials belonging to the organic series, and modifying them according to its needs.

The chemical processes carried on by organized beings range from comparatively simple ones to others that are highly complicated. A vegetable cell, such as a yeast cell, is able through its delicate walls to allow a certain intercourse between its internal contents and the matters which the fluid in which

* *Elements of Chemistry*, vol. iii. p. 723.

it grows contains. It takes from the fluid or solution what it requires for its development and reproduction, and in so doing determines certain decompositions and recompositions, which are termed fermentation, and which give rise to special products. In more complicated organic beings a great series of processes, more or less similar, are going on, and every organ is engaged in a series of transactions with fluids and gases, one result of the whole being the orderly building up, and the equally orderly taking to pieces, of the various parts which make up the entire structure.

Starches and sugars are among the most interesting products of vegetable life. Common starch consists of carbon, oxygen, and hydrogen (the proportion being C_{12} H_{10} O_{10}); and if the elements of water (oxygen and hydrogen) be added, starch sugar is the result. There are many varieties of sugar, and many substances allied to sugar, and belonging chemically to the same group. They consist of the same elements combined in different proportions. Cane sugar crystallizes in four or six-sided rhombic prisms; grape sugar in cubes or square tables; sugar of milk in four-sided prisms. Fruit sugar is not crystallizable. Gums are much like sugars in composition, and abundantly found in plants. Gum arabic has the same composition as cane sugar, C_{12} H_{11} O_{11}, and may be converted into sugar by the action of dilute sulphuric acid, which first removes one equivalent of water, and turns it into *dextrin*, a substance in properties between gum and starch.

Vegetable jelly (pectin) gives their gelatinous character to the juice of many fruits, and *pectose*, which may be converted into it, abounds in carrots, turnips, etc.

Silica, or flint, pure in white quartz crystals, is often met with by the microscopist in vegetable bodies, such as wheat straw, the glazed surface of canes, the spicules of certain sponges, and so forth. In these cases it has been deposited by organic agency in an organic structure. Silica is composed of silicon and oxygen, and is one of the most abundant constituents of the earth's crust. Silica or silicic acid crystallizes in six-sided prisms, terminated by six-sided pyramids. It requires an intense heat to melt it, and is insoluble in all the acids except hydrofluoric. One of its modifications is slightly soluble in water, and it may be precipitated in a gelatinous form from solutions of silicates of soda and potash. Diatoms, and many other organized beings, can separate from water the minute quantity of silica necessary for their hard structures. When the microscopist is in doubt whether a substance is silica, or carbonate, or oxalate of lime (the last common in plants as raphides), he should apply a drop of muriatic acid. If lime it will be dissolved, if silica not. Oxalate of lime crumbles to an

opaque powder when heated red hot. Silica, if pure, remains unchanged in form, and keeps its transparency, or it becomes white, if minute portions of other earths are present. In sponge spicules an animal substance is present, and this blackens with heat.

Silica is contained abundantly in common minerals, agates are chifly composed of it; the opal has it for its chief constituent; sharp sand is mostly composed of particles of silex, and sandstone contains it in large quantity.

The few hints given in this paper, and in the preceding one on *Organic Chemistry* will, it is hoped, give young microscopists some help, but they must make a special study of chemistry if they wish to do more than approach the threshhold of many very interesting questions in the growth and decay of living beings on which the microscope is able to throw light, but which without chemical knowledge must remain more or less unintelligible.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1866. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.*	Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
July 1	...	...	...	...	...	66·8	53·5	13·3	...	...	0·857
„ 2	29·375	54·0	46·8	·78	·427	64·6	49·7	14·9	10, 7, 5	WSW, WSW, W.	·064
„ 3	29·367	53·7	47·6	·81	·423	62·9	50·0	12·9	9, 8, 9	W, WSW, SW by S.	·010
„ 4	29·478	55·5	49·4	·81	·450	65·8	50·7	15·1	10, 8, 9	SW, W by S, SW.	·160
„ 5	29·508	55·4	47·6	·77	·448	64·7	51·1	13·6	6, 7, 8	SW by W, SW, SW.	·116
„ 6	29·626	56·6	47·9	·74	·467	67·2	49·7	17·5	9, 7, 4	WSW, NW by N, W.	·106
„ 7	30·009	56·5	41·8	·60	·465	64·8	48·5	16·3	7, 5, 4	W, NNW, NW by W.	·096
„ 8	...	...	...	...	...	66·1	48·6	17·5	...	...	·000
„ 9	30·184	65·3	58·4	·79	·623	74·8	57·7	17·1	10, 7, 7	W, W by S, SW by W.	·004
„ 10	30·287	70·9	57·6	·65	·748	79·7	58·0	21·7	0, 3, 2	WSW, WSW, NW by W.	·000
„ 11	30·277	70·4	57·6	·66	·736	77·5	56·7	20·8	1, 2, 7	—, NW by W, E by N.	·000
„ 12	30·163	74·9	61·4	·64	·851	84·3	56·3	28·0	0, 4, 1	—, SE, SE.	·000
„ 13	30·058	75·0	59·8	·61	·854	82·7	60·2	22·5	0, 1, 7	S, W by S, W by S.	·000
„ 14	30·125	71·0	59·8	·69	·750	80·6	57·9	22·7	4, 6, 4	—, SW, SSW.	·000
„ 15	...	...	...	...	...	79·2	58·0	21·2	...	...	·000
„ 16	30·079	63·5	54·9	·75	·587	72·9	59·0	13·9	7, 4, 5	E by NE, ENE, E by S.	·000
„ 17	30·022	61·0	52·5	·75	·540	68·8	58·6	10·2	10, 9, 9	NE, NE, NE.	·000
„ 18	29·963	61·6	47·0	·61	·551	70·6	48·7	21·9	4, 4, 2	NE by N, NE, NE.	·000
„ 19	29·894	60·0	51·6	·75	·523	69·7	49·3	20·4	1, 8, 7	NE by N, NE, NE by N.	·000
„ 20	30·051	59·3	46·4	·64	·511	69·6	47·5	22·1	9, 3, 0	NW by N, NE by N, NW by N.	·000
„ 21	30·057	67·4	51·8	·60	·667	77·3	48·5	28·8	0, 1, 3	—, W, W by N.	·000
„ 22	...	...	...	...	...	66·8	52·2	14·6	...	...	·000
„ 23	30·006	57·6	48·1	·73	·483	67·8	47·5	20·3	9, 1, 2	N by W, NE by N, N.	·000
„ 24	30·047	56·2	46·7	·72	·460	67·7	52·8	14·9	10, 10, 9	NE, NE, NE.	·000
„ 25	30·213	56·0	48·6	·78	·457	65·9	52·3	13·6	9, 9, 10	NE by N, NNE, N by E.	·000
„ 26	30·098	60·1	50·3	·72	·525	70·1	48·7	21·4	9, 10, 10	—, SW by S, SSW.	·000
„ 27	29·767	58·3	56·7	·94	·494	66·7	55·0	11·7	10, 10, 10	S, S by W, S.	·034
„ 28	29·642	60·2	55·9	·87	·526	69·5	53·5	16·0	7, 10, 10	ENE, SE by E, SE by S.	·050
„ 29	...	...	...	...	...	67·7	58·1	9·6	...	...	·424
„ 30	29·795	58·1	42·2	·58	·491	65·4	50·1	15·3	7, 8, 5	NW by N, NW by W, NW.	·005
„ 31	29·666	50·1	48·0	·93	.374	58·4	45·6	12·8	10, 10, 10	WSW, WNW, NW by W.	·004
Daily Means.	29·914	61·1	51·4	·73	·551	...	...	17·5	...	...	1·930

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—JULY, 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
A.M. 12	16	11	7	5	16	7	5	6	12	6	3	2	3	4	4	9	12	7	2	3	3	11	3	7	8	2	6	3	3	9	4	6·4
1	16	10	10	7	18	7	3	6	12	7	2	1	6	4	1	7	14	7	2	6	2	11	5	8	9	2	6	3	2	9	8	6·7
2	13	10	10	8	22	5	4	5	13	9	1	2	5	3	2	8	11	8	1	6	1	12	5	8	8	1	5	3	5	10	6	6·8
3	12	11	7	8	16	6	3	7	12	9	1	3	5	3	2	7	11	5	1	7	1	5	6	7	7	2	5	3	6	10	7	6·3
4	10	11	9	6	9	4	3	8	12	9	1	4	4	2	2	6	12	6	2	7	1	7	8	7	6	3	6	2	8	9	8	6·2
5	8	13	9	9	10	4	3	9	10	7	3	4	3	2	1	10	13	7	2	5	1	9	3	7	8	2	5	4	7	10	6	6·2
6	12	14	13	9	13	5	4	10	10	9	6	3	5	2	2	13	14	11	3	7	0	10	5	7	8	3	8	1	5	7	11	13	10	7·8
7	10	15	16	12	16	5	8	15	12	10	6	5	8	3	7	12	13	12	4	9	2	12	7	8	8	3	7	9	12	18	12	9·5
8	8	15	17	14	18	5	8	15	13	10	6	6	10	4	6	13	13	13	6	7	2	11	10	11	9	7	6	10	13	15	17	10·2
9	8	15	16	14	19	5	9	14	12	9	4	5	9	1	3	13	12	14	7	13	3	10	11	12	9	7	3	12	13	17	17	10·2
10	10	10	17	17	17	8	12	15	14	11	7	7	10	4	4	16	11	15	7	15	4	9	12	13	10	8	4	13	16	17	18	11·3
11	13	13	15	16	15	4	8	17	16	10	5	7	11	6	4	17	12	12	7	13	3	9	13	15	8	9	7	15	16	15	16	11·2
12	15	14	15	19	19	5	12	14	15	11	5	8	11	7	9	19	14	13	11	15	5	10	12	16	9	11	6	15	14	16	15	12·2
P.M. 1	16	15	20	20	16	7	11	17	16	10	6	10	10	6	8	18	14	10	13	9	5	9	15	15	10	11	8	14	18	14	16	12·5
2	14	10	18	20	19	8	12	15	16	11	9	10	12	7	8	18	13	10	15	8	6	9	14	16	13	13	8	10	16	13	21	12·6
3	13	10	20	20	20	10	15	12	15	12	7	10	12	6	8	18	14	12	13	7	4	11	13	17	11	13	8	13	20	13	16	12·6
4	17	16	26	18	19	6	14	15	15	10	5	9	10	5	8	18	14	13	12	5	3	11	15	15	11	12	8	9	13	11	16	12·2
5	15	14	18	14	17	6	12	12	13	10	4	9	9	4	7	19	13	10	11	1	3	10	17	11	8	10	6	8	21	6	15	10·7
6	17	1[illegible]	18	16	14	5	11	10	12	6	4	6	7	5	5	18	13	9	9	3	8	12	17	12	3	7	7	9	18	12	14	10·4
7	10	1[illegible]	14	13	15	4	5	13	11	3	5	5	6	4	9	15	11	6	14	2	12	5	13	15	7	5	8	10	13	5	18	9·3
8	9	10	8	16	9	4	5	11	8	3	2	6	4	1	11	17	8	4	10	3	8	2	9	9	5	6	5	11	18	4	16	7·8
9	6	8	3	16	9	3	5	11	6	5	2	5	5	2	14	17	7	5	5	3	8	2	5	9	3	7	6	10	7	4	14	6·8
10	9	9	3	18	7	2	7	11	8	3	2	6	5	3	13	11	10	2	4	5	11	3	10	10	3	7	6	6	12	4	15	7·2
11	8	8	3	15	10	3	6	11	6	2	2	4	4	3	8	9	8	1	1	2	12	3	8	7	3	6	5	5	10	6	10	6·1
12																																
Total Daily Movement.	285	290	312	330	363	128	185	279	289	192	98	137	174	91	146	328	287	212	162	161	108	203	236	262	184	155	146	204	292	260	312	9·1

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1866.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		Rain—read at 10 A.M.
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
Aug. 1	29·901	59·5	50·3	·73	·514	69·3	50·6	18·7	10, 6, 4	W by N, S, S.	0·127
„ 2	29·566	60·9	56·9	·87	·539	70·7	55·9	14·8	10, 9, 10	SW by W, WNW, NW by W	·084
„ 3	29·744	62·0	54·6	·78	·559	71·2	55·2	16·0	10, 7, 9	SW by W, SW, W.	·065
„ 4	29·704	57·3	42·8	·61	·478	66·0	50·7	15·3	9, 8, 5	SW by W, WSW, SW by W.	·000
„ 5	...	...	...	...	...	64·5	51·1	13·4	...	... ...	·000
„ 6	29·715	52·0	50·8	·96	·399	...	49·3	...	10, 10, 10	SW by W, SW, SW.	·472
„ 7	29·446	55·5	50·0	·84	·450	66·6	...	...	5, 6, 4	SW by S, W, W.	
„ 8	29·653	55·8	48·5	·78	·454	64·8	50·3	14·5	7, 7, 6	SW, SW by S, S by W.	·111
„ 9	29·564	58·0	42·7	·59	·489	66·1	51·2	14·9	6, 6, 5	W, W by N, W by N.	·147
„ 10	29·721	54·3	44·8	·72	·432	64·6	48·2	16·4	5, 8, 7	WNW, W, SW by W.	·002
„ 11	30·083	58·0	46·8	·68	·489	67·9	49·3	18·6	6, 7, 9	WNW, W, W.	·134
„ 12	...	...	...	...	...	65·7	51·4	14·3	...	... ...	·316
„ 13	29·918	...	...	...	...	...	55·4	...	9, 10, 10	NE by N, —, —.	·051
„ 14	29·777	58·5	53·7	·85	·497	66·7	...	...	10, 9, 6	SW by S, NNW, NW.	·050
„ 15	29·950	55·6	46·4	·73	·451	64·0	52·1	11·9	10, 10, 8	W, W by S, W.	·005
„ 16	29·69	55·3	48·9	·80	·447	63·7	52·1	11·6	10, 9, 6	SW by S, SW, WNW.	·000
„ 17	29·788	56·2	43·0	·64	·460	64·4	49·2	15·2	8, 8, 8	W, W by S, WNW.	·060
„ 18	29·946	58·5	46·9	·67	·497	68·8	45·9	22·9	5, 6, 2	W, WSW, S by W.	·001
„ 19	...	...	...	...	...	70·8	42·2	28·6	...	... ...	·000
„ 20	29·691	62·1	54·4	·77	·561	70·6	54·8	15·8	7, 5, 5	NNW, N, N by W.	·062
„ 21	29·830	58·5	55·2	·89	·497	67·7	56·0	11·7	10, 8, 8	NW by N, N by W, W by N.	·010
„ 22	29·979	60·9	54·3	·80	·539	70·4	55·7	14·7	10, 7, 5	SW, —, —.	·000
„ 23	30·010	61·8	56·9	·79	·555	73·5	51·7	21·8	10, 7, 2	E, E by N, E.	·000
„ 24	29·996	63·2	61·9	·96	·581	69·7	56·8	12·9	10, 10, 10	E, W, E by S.	·000
„ 25	30·059	62·8	57·4	·83	·574	71·7	50·4	21·3	4, 8, 8	WSW, S, SSW.	·070
„ 26	...	...	...	...	...	75·7	54·2	21·5	...	... ...	·008
„ 27	29·804	63·8	52·8	·69	·593	72·9	59·4	13·5	8, 7, 3	SW by S, SW by W, WSW.	·000
„ 28	29·514	59·7	54·9	·85	·518	68·8	53·2	15·6	9, 10, 9	SE, ESE, S.	·000
„ 29	29·308	51·7	53·0	1·00	·395	59·5	52·3	7·2	10, 10, 10	SE by S, WNW, WSW.	·096
„ 30	29·716	56·0	46·0	·71	·457	65·7	52·9	12·8	1, 10, 8	NW, W, S by W.	·500
„ 31	29·860	60·0	48·2	·67	·523	69·4	46·5	22·9	1, 5, 3	SW by S, SSW, WSW.	·064
Daily Means.	29·776	58·4	50·8	·74	·498	...	...	16·2	...	... ...	2·435

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—August, 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12	12	15	13	9	11	6	23	16	13	7	9	6	7	8	7	5	14	8	1	5	2	5	3	10	3	2	6	6	3	13	5	8·2
A.M. 1	11	13	10	11	12	7	25	14	12	7	8	8	9	8	6	5	15	7	1	3	4	3	3	10	4	1	7	4	1	14	5	8·0
2	9	13	7	11	11	6	19	10	12	6	8	6	8	8	5	5	16	7	1	3	5	5	3	8	3	3	7	3	2	16	2	7·3
3	8	12	5	10	11	6	20	10	11	7	6	9	10	8	4	6	17	4	3	8	7	3	4	6	1	2	5	3	3	15	1	7·3
4	6	10	9	13	12	7	19	11	12	7	5	12	7	6	4	5	14	4	1	2	6	3	2	6	2	3	5	3	2	17	1	7·0
5	6	10	7	17	10	6	12	10	9	5	7	11	6	8	7	5	10	3	3	3	4	5	6	6	2	2	3	2	1	15	1	6·5
6	7	10	10	18	10	7	14	10	14	6	8	10	8	10	10	8	13	4	4	3	4	3	4	7	2	3	5	6	2	16	1	7·6
7	7	8	13	21	13	10	8	13	17	10	11	9	9	8	10	10	15	6	5	4	6	5	4	7	5	1	9	7	3	12	1	8·6
8	6	8	15	22	14	14	17	14	13	11	8	6	10	9	11	13	16	6	5	2	7	4	5	7	8	1	11	8	5	14	3	9·4
9	5	9	19	32	10	16	20	17	10	10	8	5	7	9	9	17	17	8	7	4	7	3	7	5	8	6	14	8	6	13	3	10·3
10	5	9	17	29	16	16	19	17	13	13	7	4	7	8	10	19	16	12	11	2	7	6	7	2	9	12	12	12	9	13	4	11·1
11	5	9	17	25	14	15	23	11	16	11	8	4	4	10	10	15	16	10	12	4	5	4	5	4	10	16	13	13	9	11	7	10·8
12	5	10	19	24	12	15	25	24	13	13	8	4	5	13	10	15	13	9	11	4	8	7	8	2	10	15	16	14	15	14	6	11·8
P.M. 1	8	6	17	24	16	18	22	18	15	10	10	5	4	12	8	14	13	9	12	4	8	3	10	4	7	18	16	14	8	12	4	11·2
2	7	11	18	20	14	20	22	25	16	9	9	5	2	16	6	17	16	10	10	5	9	5	15	5	8	17	14	12	10	9	6	11·9
3	12	13	11	20	15	21	25	30	17	13	10	4	1	12	11	20	18	11	9	4	12	4	17	3	8	18	16	11	13	9	6	12·8
4	19	12	22	23	15	22	22	27	13	13	8	4	2	9	10	18	16	9	10	4	8	4	16	5	10	16	16	8	18	6	6	12·6
5	17	10	19	22	12	25	23	23	13	8	4	2	3	12	8	13	15	11	10	3	5	4	16	4	9	10	15	7	16	14	7	11·6
6	17	7	18	20	9	26	20	25	11	4	11	3	4	10	4	10	12	9	10	2	4	1	14	3	5	9	17	3	15	8	6	10·2
7	12	9	14	13	7	25	22	24	9	7	12	2	5	12	4	10	16	10	8	4	4	3	17	3	5	7	8	6	13	10	6	9·9
8	10	10	9	14	5	24	19	21	6	5	10	3	7	11	4	6	8	6	7	5	4	4	15	6	5	7	9	4	11	6	7	8·6
9	10	9	12	13	6	25	17	14	7	7	8	2	6	10	6	12	7	5	7	5	5	7	13	2	4	6	6	4	7	6	7	8·2
10	19	10	13	13	7	22	17	14	6	7	9	4	6	7	6	13	8	3	5	1	4	5	17	6	2	4	5	4	14	6	4	8·0
11	12	10	10	11	7	21	15	16	6	8	7	5	8	6	5	14	7	2	5	2	5	4	12	5	2	4	7	2	4	6	5	7·7
12																																
Total Daily Movement.	226	243	324	435	269	380	468	414	284	204	199	133	145	230	175	275	328	173	158	86	140	96	223	126	132	183	242	164	190	275	104	9·4

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1866.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		
			Calculated.								
Day of Month.	Barometer corrected to Temp. 32.°	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Sept. 1	29·871	60·2	48·0	·66	·526	67·6	51·6	16·0	2, 6, 4	SW, SW, SW.	0·000
„ 2	...	...	...	...	...	64·1	54·3	9·8	...	... ...	·082
„ 3	29·849	56·2	43·2	·64	·460	64·7	45·5	19·2	1, 2, 2	WNW, W, W.	·138
„ 4	29·609	58·8	58·8	1·00	·502	66·4	51·9	14·5	10, 10, 10	SSW, SSW, SW.	·061
„ 5	29·403	61·0	55·9	·84	·541	68·4	61·4	7·0	10, 6, 3	SW by W, SSW, SW by W.	·447
„ 6	29·574	57·9	54·8	·90	·487	65·4	54·8	10·6	5, 10, 10	SW, S, S.	·025
„ 7	29·604	58·7	53·9	·85	·501	65·6	57·2	8·4	8, 9, 10	WSW, W, SW.	·655
„ 8	29·688	54·0	53·5	·98	·427	60·9	55·0	5·9	10, 10, 10	E, NNE, —.	·007
„ 9	...	...	...	...	...	65·0	53·1	11·9	...	... ...	·248
„ 10	29·525	58·1	51·7	·81	·491	66·3	55·6	10·7	8, 4, 2	SW, SW by S, SW by W.	·130
„ 11	29·535	54·1	49·2	·85	·429	61·8	52·3	9·5	10, 7, 7	SW by S, SW, W.	·143
„ 12	29·923	49·0	44·3	·85	·361	57·8	49·3	8·5	5, 10, 10	W, SW by W, SW.	·007
„ 13	29·799	55·4	47·0	·75	·448	63·4	49·7	13·7	10, 6, 10	SW by W, WSW, W.	·026
„ 14	29·548	54·4	45·9	·75	·433	63·3	52·9	10·4	8, 6, 8	SW, W, W.	·367
„ 15	29·713	53·1	47·1	·82	·415	63·5	47·3	16·2	2, 7, 8	SW by S, S, S by W.	·022
„ 16	...	...	...	...	...	59·9	47·4	12·5	...	... ...	·079
„ 17	29·737	54·0	42·7	·68	·427	61·5	48·3	13·2	4, 6, 6	NW by W, W by N. N.	·204
„ 18	30·053	53·0	47·1	·82	·413	60·1	38·5	21·6	3, 10, 10	SW by S, S, SSW.	·012
„ 19	29·929	55·1	51·7	·89	·444	64·1	53·9	10·2	9, 10, 9	SW, SW by W, WSW.	·005
„ 20	29·930	52·6	47·6	·84	·408	59·8	47·5	12·3	10, 10, 9	W by S, SW by W, SW by W.	·052
„ 21	29·608	52·1	43·1	·74	·401	59·5	52·3	7·2	7, 8, 7	W, WSW, SW by W.	·140
„ 22	29·278	47·0	45·0	·94	·337	54·1	46·1	8·0	10, 10, 9	NNW, W by S, SW.	·449
„ 23	...	...	...	...	...	57·1	44·8	12·3	...	... ..	·009
„ 24	29·701	52·4	48·7	·88	·405	59·0	46·1	12·9	9, 8, 3	S by W, WSW, SW.	·081
„ 25	29·971	53·4	44·8	·74	·419	60·9	34·7	26·2	0, 1, 4	S, S, SSW.	·047
„ 26	29·936	55·8	53·7	·93	·454	62·5	50·9	11·6	10, 7, 1	S, W by S, WSW.	·017
„ 27	29·925	55·5	50·3	·81	·450	63·7	50·2	13·5	10, 4, 1	W, WSW, W by N.	·107
„ 28	29·793	58·9	55·1	·88	·504	69·1	49·3	19·8	9, 10, 8	E by N, ESE, ESE.	·021
„ 29	29·892	58·5	56·1	·92	·497	66·5	56·2	10·3	9, 10, 8	W by S, —, —.	·000
„ 30	...	...	...	...	...	64·6	56·5	8·1	...	... ...	·007
Daily Means.	29·756	55·2	49·6	·83	·447	...	...	12·4	...	... ...	3·588

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—SEPT., 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour.																															
12																															
A.M. 1	4	10	8	5		18	28	3	2	17	17	14	8	14	10	10	16	3	20	8	23	9	2	6	2	3	2	2	13		9·9
2	6	10	9	5	241	15	27	2	4	18	12	14	8	16	11	9	16	3	18	7	25	11	1	5	1	3	2	2	9		9·6
3	8	10	9	7		12	27	1	3	17	16	12	9	19	9	8	13	5	20	8	21	9	1	6	2	5	1	4	6	170	9·5
4	8	11	10	6		14	30	2	1	13	16	12	11	15	8	9	13	4	22	7	17	6	2	5	1	6	3	5	8		9·4
5	6	16	7	6		15	26	2	2	10	14	10	8	13	8	11	11	3	19	6	10	7	2	2	2	8	6	6	6		8·6
6	11	15	8	5		10	34	1	2	7	13	10	6	13	8	9	11	2	12	9	10	5	2	8	2	9	4	6	6		8·5
7	9	15	11	7		12	43	2	4	9	17	10	9	10	6	10	9	3	12	7	12	11	2	8	2	11	1	6	4		9·3
8	12	16	14	10		15	37	4	2	10	22	11	12	12	10	15	10	5	13	7	12	12	5	10	1	8	0	9	3		10·4
9	13	17	17	16		14	34	3	5	11	23	12	11	19	12	16	10	5	20	11	13	12	2	14	4	7	1	11	4		12·0
10	15	17	18	19		15	32	3	8	12	21	12	14	22	16	18	12	10	17	11	20	12	4	12	13	7	4	10	3		13·4
11	12	22	17	19	25	17	18	7	8	16	24	13	13	19	15	20	13	13	18	13	16	13	2	14	17	5	3	11	3		14·0
12	16	11	17		25	16	20	8	9	16	24	10	10	23	18	21	10	13	19	15	16	12	4	15	17	7	5	11	5		14·4
P.M. 1	19	14	18		22	19	17	7	11	18	25	13	10	23	17	25	10	15	22	15	21	11	7	16	19	6	3	14		7	15·5
2	20	14	16		23	18	13	5	14	19	25	10	12	22	18	18	11	16	22	15	17	10	7	12	19	8	2	11		5	14·3
3	21	15	15		25	16	13	7	15	19	24	10	12	11	22	16	12	18	19	15	21	10	4	15	17	3	2	16		6	13·5
4	19	15	18		23	19	11	4	15	23	22	10	14	19	13	13	9	17	16	16	16	11	2	15	15	7	2	14		3	13·6
5	21	15	17		26	26	11	5	13	19	25	9	11	19	14	25	10	17	18	18	17	10	2	15	9	6	1	10		3	14·0
6	16	8	13		23	27	9	7	14	15	24	9	7	14	13	18	6	19	15	16	16	10	3	9	7	5	1	6		0	11·7
7	15	13	9		20	30	10	5	12	15	21	7	8	12	6	12	3	20	12	18	8	7	3	6	6	5	0	6		3	10·4
8	12	11	9		27	25	9	2	12	13	20	6	11	12	6	10	4	19	11	17	13	8	5	4	9	5	2	10		8	10·7
9	13	12	8		23	25	5	5	14	17	19	4	11	13	10	11	4	20	11	24	12	6	4	5	8	4	2	10		5	10·9
10	10	8	7		20	25	4	4	11	13	19	2	13	13	8	4	3	18	10	23	13	5	4	6	11	2	3	9		6	9·8
11	8	8	10		18	24	4	6	14	17	16	5	10	13	11	9	3	18	10	27	11	4	5	3	13	2	3	10		8	10·4
12	9	7	8		17	31	3	3	14	15	12	8	10	13	9	11	4	19	9	25	11	3	6	12	6	3	2	12		10	10·4
Total Daily Movement.	303	310	293	422		458	465	101	209	359	471	233	248	379	278	328	223	285	385	338	371	214	87	223	203	135	55	211	305		10·9

THE NEBULAR HYPOTHESIS OF LAPLACE EXPLAINED BY DELAUNAY.

RECENT investigations into the nature of nebulæ have strongly revived public interest in what is called the "Nebular Hypothesis," and as fresh facts, which we may expect to be made known by further research, promise to supply arguments for and against this theory of the origin of suns and planets, it is well that clear ideas should be entertained concerning the views which Laplace held. Professed students of astronomy are sufficiently acquainted with them; but to the general scientific reader, the following explanation, given by M. Delaunay, in his *Cours Elémentaire d'Astronomie*, 4th edit., will be acceptable. He tells us that "in adopting the ideas of Herschel concerning the progressive condensation of nebulæ, and their transformation into stars, and in applying these ideas to our planetary system, Laplace arrived at the most satisfactory mode of explaining their formation. No peculiarity that observation has disclosed relative to planets or their satellites, has escaped the ingenious explanation which he has developed at the close of his *Exposition du système du Monde*, of which we shall proceed to give an idea."

"Laplace supposes that in the beginning, the sun, and all the bodies circulating round him formed a single nebula, animated by a movement of rotation about a line passing through its centre, and extending to the orbit of the most distant planet, or beyond it. He further conceives that by reason of a progressive cooling, larger and larger portions of nebulous matter were condensed at its centre, so as to form a nucleus, the mass of which gradually enlarged. Starting from this supposition, he demonstrated that in the course of time the nebula would be reduced to the state in which we actually find the planetary system."

"In proportion as the cooling caused the condensation of new parts of the nebula, the materials so condensed would fall towards the centre just as drops of rain fall through the condensation of the vapour contained in our atmosphere. But this fall of condensed matter could not take place without occasioning an acceleration of the velocity with which the entire nebula turned upon its axis. Matters condensed and falling towards the centre of the nebula would acquire a movement of rotation about its axis more rapid than that of the rest of the mass. Then the friction of different parts of the nebula, one against another, would accelerate the motions of those turning less rapidly, and would lessen the rapidity of those moving with greater velocity, and after a certain lapse of

time, the entire mass of the nebula would revolve with an angular velocity greater than that which it had in the beginning. Thus the progressive condensation of the primitive gaseous matters of the nebula, and their agglomeration about its centre, necessarily produces a continual augmentation in the velocity of the nebula's rotation about its own axis."

"A nebula such as we have imagined, animated with a movement of rotation about its axis, cannot extend itself in the plane of its equator beyond a certain limit, the position of which depends on the velocity of its motion. Any molecule situated in the plane of the nebula's equator, and participating in its movement, must be subjected at one and the same time to the attraction which the entire mass can exert upon it, and also to the centrifugal force resulting from its rotatory motion. The dimensions of the nebula cannot remain such as would cause the second force to prevail over the first even at any part of its equator, for should this happen, and any molecules be impelled by centrifugal force beyond the control of gravitation, they would cease to form part of the nebula, and move off, independently of it, with the velocity that they possessed at the instant of their starting away."

"The progressive condensations of different portions of the matter forming the nebula would, as we have said, accelerate its rotation, and by consequence give rise to a corresponding augmentation of centrifugal force for any point situated at a given distance from its axis, and thus the limit beyond which the nebula could not extend and cohere would become more and more restricted."

"If at a certain epoch, this limit, measured from the centre, terminates at the surface of the nebula, the condensation to which this further cooling will give rise must cause the limit to fall within the surface, and then the outside molecules of the nebula surrounding its equator will be beyond this limit, and consequently this excess of matter beyond that which the nebula can retain by means of its attraction, will cease to be a portion of the mass, and will separate in the form of a ring, rotating in its own plane about its own centre with the velocity which it possessed at the moment of its detachment. It is only about its equator that the nebula can abandon portions of the matter composing it; for in no other place, except in the plane of this circle, can a molecule be acted upon by the attractive force in the same line as that in which the centrifugal force operates. These two forces compose a resultant force,*

* For those who are unacquainted with this term as used in mechanics, we may explain its meaning by stating, that if one force impels a ball straight forward, and a second force of the same amount impels it exactly across, or at right angles to, the line of the first force, the two forces will combine into a *resultant* force, sending it in an intermediate direction.

which tends more and more to make the molecule approach the equator, in proportion as the centrifugal force is increased. The increase of angular velocity in the rotation therefore causes the surface molecules to move from all parts towards its equator, and then to be abandoned into space as we have described."

"It will be understood that our nebula, in its process of cooling, has thus abandoned successively, in the plane of its equator, divers rings of nebulous matter, which continue to revolve in the same plane, and about a common centre. The central mass to which successive condensations have reduced the nebula, is no other than the sun; and the concentric rings of nebulous matter thrown off in succession in the plane of its equator will give rise to planets, as we shall proceed to show."

"Each ring must be perfectly regular, in order to preserve its annular form for an indefinite time. This regularity can only exist under exceptional circumstances, and it is natural to suppose they are wanting in the case before us. Thus the matter belonging to each tends to assemble about certain centres of attraction, and their partial condensation divides the ring into fragments, which continue to move separately very much as they did when united. The velocity of the various parts which once formed one ring not being rigorously the same, either because they were not equal at the moment of separation, or were subsequently changed by the perturbing action to which the whole system is exposed, it follows that the different portions can rejoin each other, and end in forming a single mass, circulating round the sun in an orbit nearly corresponding with the circumference of the ring from which it originated, and this mass condenses itself into a planet. It may, however, happen that the various fragments into which a ring was decomposed will continue to revolve as separate bodies, and give rise to many distinct planets moving in almost the same orbits, and it is thus that the planetoids between Mars and Jupiter may have resulted from the fragments into which one nebulous ring may have been divided."

"Let us now see what becomes of the materials of an entire ring, united together about one point of its circumference as we have supposed, and let us endeavour to understand how the mass thus formed has been able to produce a planet turning upon its own axis, and accompanied by satellites, as is generally the case in our planetary system. In the progressive condensation of such a mass, the molecules most remote from the sun have approached nearer to that body, and the molecules which were nearest have become more remote; the first having a greater, and the latter a smaller velocity, than that of the mean portions towards which they are moving by the

process of condensation, and hence must arise a movement of rotation round a centre, and in the same direction as the revolution of the whole mass round the sun. Henceforth the materials of a ring abandoned by a nebula become a system analogous to the nebula, but of much smaller dimensions. They have given rise to a new nebula moving round the centre of the original nebula, and in the same direction. This new nebula would, by successive condensations, throw off in succession different rings of nebulous matter, and would at last form a planet turning on its own axis, and revolving in the same direction round the sun. The abandoned rings of matter would behave just as those thrown off by the original nebula, and give birth to the satellites of the planet. Some rings may preserve an exceptional regularity, and thus, as in the case of Saturn's appendages, be able to retain their original form."

"The matter united at a certain distance from a planet to form a satellite, would elongate itself in the direction of a line joining the planet, just as the action of the moon determines an elongation of the sea in the direction of a line joining the earth and moon. This elongation of a satellite while in its fluid state—much greater than in the comparison just made—would give it a tendency always to turn the same points of its surface towards the centre of the planet; and thus may be simply explained this remarkable fact with reference to the moon, which, as Herschel thought, was also exhibited by Jupiter's satellites."

"We see that the hypothesis of Laplace on the origin and formation of our planetary system takes due cognizance of all the peculiarities by which it is characterised. Almost complete coincidences in the planes of the orbits of the planets, slightness of the eccentricity of their orbits, identity of direction in the movements of rotation and revolution throughout the system—all is explained in the most natural manner, and in conformity with the laws of mechanics."

"In this hypothesis the body of a planet formed by condensations such as we have described, would at first be a liquid mass affecting the form of a spheroid flattened in the direction of its axis of rotation, and surrounded by an atmosphere the residue of the nebula from which it sprung. This liquid mass, continuing to grow cooler, would solidify little by little over its whole surface. The solid crust thus formed would be gradually altered in shape, and at last would split in several parts, by reason of the progressive diminution of the liquid volume in its interior, as the temperature was lowered. In the mean time if the atmosphere contained a great quantity of aqueous vapour its condensation would form enormous masses of water, which would occasion degradations of the surface,

and a transport of matter which would be deposited in horizontal layers at the bottom of the vast basins in which the waters would congregate. These phenomena would continually be reproduced through the successive evaporations and condensations which the water would experience through the high temperature of the surface of the globe, and through the continual refrigeration of the atmosphere. Thus the successive formations on the terrestrial globe, which it belongs to geology to elucidate, would arise naturally out of the circumstances we have considered."

"The comets which from time to time pass near the sun cannot be regarded as arising from the nebula which we have supposed to be the origin of the sun and planets, and of their satellites. These comets must be regarded as small nebulæ moving in immensity, and which on approaching our system are drawn into it by the sun's attraction, and which after coming near him, recede, often never to return. When a comet thus journeys near our sun and planets, their actions upon it may modify the line in which it moves, so as to convert it into an ellipse with a major axis not extravagantly great; and thus the comet may become periodic, and an integral part of our system. Four known periodical comets seem to be in this condition, but it may happen that the disturbing actions of the planets, near which they pass, may so modify their orbits as to elongate them indefinitely from us, without absolutely preventing their return; and there are instances of comets whose movements have been effected by actions of this kind."

"The zodiacal light is readily explained according to the hypothesis of Laplace. It cannot be regarded as due to the atmosphere of the sun, as it extends beyond the orbits of Mercury and Venus, and thus exceeds the limits within which the solar atmosphere must be circumscribed through the velocity of the sun's rotation; but we might conceive that some of the matter successively abandoned by the nebula which formed our planetary system, might not be totally condensed into the various masses out of which the planets were formed. Small quantities of this matter might remain and form a very diffuse lenticular nebula, such as the zodiacal light. Many examples of such elongated nebula are found in the heavens. It may also happen that nebular matter diffused in the space surrounding the sun might be condensed into an immense number of little planets, and in this way we may explain the origin of shooting stars, whose periodical return gives some countenance to such a theory."

LITERARY NOTICES.

RELIQUIÆ AQUITANICÆ: being Contributions to the Archæology and Palæontology of Périgord, and of the adjoining Provinces of Southern France. By EDWARD LARTET and HENRY CHRISTY. Part III. (Baillière.)—The present part of this important and remarkably handsome work, commences by describing the mode in which the Indians of California fashion their stone arrow-heads; and cites from Sir. E. Belcher the way in which the Esquimaux of Cape Lisburne manage, by pressing the hard points of reindeer-horn upon fractured pieces of chert, to produce saw-like edges, which it might be supposed required the agency of metallic tools. The caves of Dordogne then form the subject of remark, and it is stated that, besides ossiferous deposits which may have resulted from water action, others must have been accumulated when the caves were the abodes of wild animals or of men. "Some have been the resorts of beasts alone, and some only inhabited by men. In the comparatively few in which they have been tenanted by both, there are usually indications that the earlier occupancy has not been that of man." "It is especially in the valley of the Vezère, a tributary of the Dordogne, which is an affluent of the Garonne, that these remains are in great abundance, and are indisputably contemporaneous with the remains of animals extinct in that country before history or tradition." The cave-deposits are composed of broken bones, pebbles, nodules, and chips of flint of various sizes, intermixed with charcoal in dust and in small fragments. Besides these, a multitude of implements of deer-horn have been discovered, some finished, and others in process of formation. "These consist of square chisel-shaped implements; round, sharp-pointed, awl-like tools, some of which may have also served as the spikes of fish-hooks; harpoon-shaped lance-heads, plain or barbed; arrow-heads with many and sometimes double barbs, cut with wonderful vigour; and lastly, eyed needles of compact bone, finely pointed, polished, and drilled with round eyes, so small and regular that some of the most assured and acute believers in all other findings, might well doubt whether, indeed, they could have been drilled with stone, until their actual repetition, with the very stone implements found with them, has dispelled their honest doubts. More than this, all but two of the many deposits explored, have given more or less examples of ornamented work; and three of them (Les Eyzies, Laugerie Basse, and La Madeleine) drawings and sculptures of various animals, perfectly recognizable as such." Thus it appears that these early inhabitants of France were considerably removed above what is ordinarily meant by the savage state. They had, as the remains clearly show, abundance and variety of food, they could make implements requiring considerable skill, and they amused themselves with rude, though by no means despicable works of art. To estimate the date of their existence is extremely difficult, and indeed sufficient means for estimating the precise geological time, and converting that into common time, do not exist. Not only have animals

then living become extinct, but, as the following passage shows, there is reason to believe that considerable changes of climate have taken place. The writers say, "In addition to the presumption of a once colder climate, which is furnished by the fauna, it is difficult to suppose that, at the period when these remains were left, the climate was the same as it now is; for, though we may have examples in the habits of the present Esquimaux, that in their cold climate it is possible to live, without detriment to health, amid an accumulation of animal remains, the case would be very different in the south of France, where, at the temperature of the present day, such accumulations would, except in winter, speedily become a decomposing mass. That the inhabitants of that day had no such difficulty to contend with, may be inferred from their having almost invariably chosen a southern exposure, and the warmest and sunniest nooks for their residences." The plates given with this number continue the depiction of stone, bone, and horn implements, and are very well executed.

A Dictionary of Science, Literature, and Art. Comprising the Definitions and Derivations of the Scientific Terms in general use, together with the History and Descriptions of the Scientific Principles of nearly every branch of Human Knowledge. New Edition. Edited by the late W. T. Brande, D.C.L., F.R.S.L. and E., of Her Majesty's Mint; and the Rev. George Wm. Cox, M.A., late Scholar of Trinity College, Oxford. Assisted by Gentlemen of Eminent Scientific and Literary Acquirements. To be completed in Twelve Parts. Part XI. (Longmans.)—This part commences with "Rules" and ends with "Sigurdr." The various articles appear well adapted to give the information required for all ordinary purposes. Some subjects, such as "Screw-propeller," "Shooting-stars," "Siege," etc., are treated at considerable length.

A Brief Account of the Scholarships and Exhibitions open to Competition in the University of Cambridge; with Specimens of Examination Papers. By Robert Potts, M.A., Trinity College. (Longmans.)—The title, which gives the contents of this little book, will show persons intending to become students at Cambridge the useful information they may derive from it.

The Scientific and Literary Treasury. By Samuel Maunder, author of the "Treasury of Knowledge," "Biographical Treasury," etc. etc. New edition, thoroughly revised and in great part re-written, with upwards of One Thousand New Articles by James Yate Johnson, Esq., M.Z.S. (Longmans.)—This popular work was well worth revising and improving. In its present state it is a very compendious little encyclopædia, admirably adapted for family use. To get an enormous quantity of matter into a brief space the print is very small, but it is clear; and after referring to a good many of the articles, we feel justified in recommending it.

Chart of the Characteristic British Tertiary Fossils, Stratigraphically Arranged. Containing upwards of Eight Hundred Figures. Compiled and Engraved by J. W. Lowry. (Tennant.)—This beautifully engraved chart of British Tertiary Fossils will be invaluable to students and fossil collectors. It consists of a series

of folding plates, which commence with the newer and post pliocene fossils, and finish with the lower eocene. In columns on the right hand side of each plate, information is given concerning the various strata in which the organic remains are found, and the nature of the principal fossils. Many of the figures are drawn in their natural size, and in other cases their proportion is given. Mr. Lowry's name is a guarantee that due pains have been taken in all the details; and it must be admitted that he has rendered an important service to students of tertiary geology.

PROCEEDINGS OF LEARNED SOCIETIES.

MICROSCOPICAL SOCIETY OF LONDON.

THROUGH the zeal of the President, Mr. Glaisher, assisted by his council, a royal charter has been obtained for this Society, and the patronage of the Prince of Wales. Fellows will use the letters F.M.S.L. The first meeting of the season took place on the 10th October, when the charter was read, and other business transacted. The President, in the name of the Society, presented an elegant silver inkstand to T. W. Burr, Esq., F.R.A.S., F.S.C., in acknowledgment of his gratuitous services in the legal steps necessary for obtaining the charter. Mr. Slack read a paper describing a new diaphragm eye-piece, which is described in our *Notes and Memoranda*. Mr. Suffolk exhibited some metal rings, made according to his directions by Mr. Collins, and adapted for microscopic cells of various sizes and depths.

PROGRESS OF INVENTION.

THE TERRESTRIAL DARK LINES OF THE SPECTRUM.—From the moment that Wollaston observed that certain rays are wanting in the solar spectrum, their places being occupied by dark lines or bands, philosophers have been occupied in attempting to investigate their origin. These attempts have been in a great degree successful. They arise from a cause which, applied to spectrum analysis, enables us not only to detect the presence of elements so minute in quantity as to elude the most careful researches of the chemist, but to pronounce with certainty regarding the elementary substances of which the most distant stars are formed. But there is one great source of uncertainty in the application of spectrum analysis to the purposes of astronomy, the difficulty of determining whether the dark lines in the spectrum of a heavenly body belong to the light emitted by that body, or have been caused during the passage of that light through our atmosphere. This difficulty is now in a fair way of solution, if it is not already resolved. M. Jansen has

proved by the most satisfactory experiments, that a large portion of the dark lines of the solar spectrum are terrestrial, and are due to the vapour of water. When, in 1864, he ascended the Faulhorn, he found that these dark lines became feeble in proportion to the height above the level of the sea; while, on the contrary, when the light of firewood, which affords a continuous spectrum, was made to pass through several miles of air in contact with the Lake of Geneva, and therefore saturated with its watery vapour, all the dark lines of the solar spectrum were produced. And he ascertained, that with a given altitude of the sun above the horizon, the higher the dew point, the more distinct the dark lines produced in the spectrum, scarcely any being perceptible on very dry days. He verified these facts by a very effective apparatus. Having placed an iron tube of considerable length, in a box, and filled the vacant space round the tube with sawdust, to prevent radiation of heat, he transmitted the light of sixteen gas-burners, placed in a line which was a prolongation of its axis, through this tube, and a continuous spectrum was thus produced. But when he filled the tube with vapour, supplied by a steam boiler, and then transmitted the light, nearly all the dark lines were reproduced, the spectrum obtained corresponding with that formed by sunlight when the sun is very near the horizon. A detenuation of the lines produced by the earth's atmosphere renders observations regarding the constitution of the heavenly bodies founded on spectrum analysis more reliable. It also enables us to find the amount of moisture in portions of the atmosphere inaccessible to us. The solar lines predominate in the green, the blue, and the violet portions of the spectrum; the atmospheric in the red, the orange, and the yellow, being ten times more numerous than the solar lines in the same places.

NOTES AND MEMORANDA.

Light of Nebulæ.—The *Philosophical Transactions* contains a very important paper by Mr. Huggins on the spectra of some of the nebulæ, in which estimations of the amount of light emitted by some of these bodies is given. Mr. Huggins took for his standard of comparison a sperm candle of the size known as sixes. This was placed at a certain distance, and its light reduced by a neutral tint glass to $\frac{1}{200}$ of its original intensity. It was then found that nebula No. 4628 gave a light equal to $\frac{1}{1200}$ of that emitted by the unscreened candle, the annular nebula in Lyra was equal to $\frac{1}{1200}$, and the dumb-bell nebula to $\frac{1}{1200}$ of the same standard.

Plumules of the Pieris Oleracea (Canada).—These "plumules" are peculiar scales found only on males. They occur under the ordinary scales, and Mr. Watson considers that when inflated they raise up the other scales. Those of the *P. oleracea* most resemble those from *P. rapæ*, figured in *Microscopical Dictionary*, but they are not of exactly the same shape. The form is something like that of a battledore, with a pear-shaped hole at the thick end, and the handle terminating in a fringe. From the centre of the pear-shaped recess springs a peduncle with a round bag at the end of it. By this bag or bulb it is attached to the wing. A paper by Mr. John Watson on these plumules will be found in the *Entomologist's Monthly Magazine* for June, 1865. We are indebted for our

Canadian specimens to one of our Canadian subscribers, who signs himself "J. J. B.," and dates from Napanee. We beg him to accept our thanks. He compares the plumules, which he rightly designates "puffy," to a "boxing-glove with two fingers or thumbs." Mr. E. C. Rye was kind enough to compare this Canadian butterfly with others. He tells us that it is closely allied to the American *P. cruciferorum*, and that both are most likely localized forms of our common green-veined white.

Star Magnitudes.—In the *Transactions of the Manchester Philosophical Society* will be found a paper by Mr. Knott on the Comparative Magnitudes assigned to Stars by Admiral Smyth in the *Bedford Catalogue*, by Struve in the *Mensuræ Micrometrica*, and by Argelander in the *Bonner Stern-verzeichniss*. "It appears that the scales of the *Bedford Catalogue*, of the *Bonner Stern-verzeichniss* are practically identical down to the 9th mag., and assuming with M. Pogson that the 13 mag. of Argelander's scale corresponds with the 16 mag. of Admiral Smyth, we may tabulate the results below the 9th, thus:—

Mag. Sm.	Mag. A.
10	9·6
11	10·1
12	10.7
13	11·3
14	11·9
15	12·4
16	13·0"

So far as Mr. Knott's observations go, this proportion is found to hold good. He says further, "The coincidence between the scale of the *Bedford Catalogue* and that of the *Mensuræ Micrometrica* ceases practically with the naked eye magnitudes. At the 6th mag. the scales diverge, and the 11th mag. of the one corresponds with the 13th mag. of the other. Five magnitudes of Admiral Smyth's scale, below the 11th, are represented by only one magnitude in the scale of Professor Struve."

Mr. Slack's Diaphragm Eye-piece.—At the October meeting of the Microscopical Society of London, Mr. Slack exhibited a microscopic eye-piece which he had devised, and which was made by Mr. Ross for the purpose of protecting the eye against the glare of a large and strongly-lit field. It has four shutters, each capable of separate motion, and enables objects of any form to be exhibited in a field of any dimensions required, and bounded by straight lines. This field may be long or short, broad or narrow, as the object may require, and it is found that the exclusion of unnecessary light makes the objects more distinct, and avoids fatigue to the eye. The shutters are moved by small milled heads attached to the flange of the eye-piece. A similar eye-piece will probably be found convenient for astronomers when viewing the moon, or the solar disk.

Spiders and Earwigs.—An illustration of the tact and skill of the spider in dealing with a dangerous foe, may be obtained by putting an earwig into the web of the *Epeira diadema*, common in all gardens. On perceiving the earwig, the spider advances cautiously, and when near the creature turns her abdomen towards it, and shoots out a sheaf of threads which immediately adhere to the earwig. She then pats him round and round as if she were roasting him on a spit, and in the course of a few seconds he is effectually rolled up in a silk mummy cloth, from which there is no escape.

Soap Beans of China.—*Comptes Rendus* contains a paper by M. Payen on the beans of a plant belonging to the genus *dialium*, which are used instead of soap in many provinces of China. The Chinese remove the outer skin with a knife, and then rub the bean against wet linen which they wish to wash. A rinsing completes the process. The pericarp, which is dry in most beans, is of a fleshy character, and contains *saponine*, besides many other substances. M. Payen, also found in these beans a gelatinous substance, differing from pectin, pectose, etc., and which he calls *dialose*.

Earthquake in France, September 14, 1866.—M. Rovet describes the particulars of this earthquake to the French Academy. It occurred about ten minutes past five, a.m., and there were two oscillations, the first from west to east, the second south to north, and with an interval of a few seconds between them.

The spots at which the shocks were felt might be enclosed in a polygon, of which Paris, Auxerre, Tournus, Montbrison, Bordeaux, Nantes, and Rouen would form the principal summits. The west-east shock was particularly felt in Dordogne, Haute Vienne, and Charente on one hand, and Loire Inférieure and Orne on the other. The south-north shock was chiefly felt in Indre, Indre et Loire, Loire-et-Cher, Eure-et-Loir, Seine-et-Oise, and Seine, being most violent in Indre et-Loir and Soir-et-Cher. In Paris it was slight. At Perigueux the west-east shock damaged many houses, and at Luche people at work were obliged to lean against the walls to prevent their being thrown down. At St. Marc, near Orleans, two persons were thrown down, the windows broken, and doors opened. Heavy noises were heard at various places.

Flint Cores from the Indus.—The *Geological Magazine* for October has a plate of remarkably neatly worked flint cores discovered by Lieut. Twemlow three feet below the rock in the bed of the river, near Shikapoor, Upper Scinde, and described by Mr. John Evans, who remarks that further details of the rock must be obtained before their age can be determined. From their form alone he would refer them to the neolithic rather than to the palæolithic period of India. The cores are composed of fawn-coloured flint, and flakes were struck from them so as to have a regular polygonal pattern.

The "Glass Rope" of the Hyolonema.—Dr. Gray has a paper in the *Annals of Natural History* on the structure of the sponge *Hyolonema Sieboldi*, and he considers that the researches of Professor Borboza du Bocage, who has found the "glass ropes" with attached polyps off the coast of Portugal, show that the long glass, or silica spicules do not, as Schulze and some other observers have thought, belong to the sponge, but are formed by the polyps, as he affirmed long ago. M. de Bocage did not find any object attached to these spicules, and as it is plain they must have had some support, the evidence is inconclusive. We shall shortly publish a paper on this subject, and therefore say no more now.

Field Adjustment for Object Finding.—A "Subscriber" writes:—"When the position of a good specimen in a slide of Diatomaceæ has been marked, the recovery of the view is more difficult than would appear at first sight, owing to the smallness of the marking, or indicating circle, and the size and propinquity to the slide of the end of an object-glass such as Smith, Beck, and Beck's one-eighth. If, however, the observer will incline the body of the microscope towards the horizontal position, and set the *plane* side of the mirror to give an easy and convenient view of the end of the object-glass, the slide may be put in exact position at once."

The 90th Planet was discovered by Dr. Luther, of Bilk, near Düsseldorff, on the 1st of October. It is of 11 mag. 2 Oct. R.A., 0h. 8m. 42s. 07 D—2° 35′ 42″·7. Daily movement in R.A. 44s. in D—4′·2.

Porosity of Caoutchouc.—M. Payen states in *Comptes Rendus* that a microscopic examination of thin sheets of caoutchouc discloses minute holes or pores, which are rounded, and communicate with each other. Contact with liquids makes these pores more distinct. Vulcanized indian rubber exhibits narrower cavities and concentric circles spreading from one pore to another, showing successive zones of diminishing action of the sulphur. By exposure to water the caoutchouc becomes whiter and opaque through absorbing the fluid. M. Payen considers this porosity to be concerned in the dialytic action of indian rubber on gases discovered by Professor Graham.

Silvered Object Glasses for Sun Viewing.—M. Le Verrier describes in *Comptes Rendus* successful experiments made with an object-glass of 25 centimetres aperture. The silvering allowed excellent views of the sun to be made with magnification up to 300. It is found that the blue tinge of light that has passed through the silver film results from an elimination of the extreme red rays; nearly all the other rays passing through.

Metallic Film Spectacles.—M. Melsens states in *Comptes Rendus* that having suffered from an accident, by which his eyes were rendered exceedingly averse to light, he found the greatest relief by employing spectacles containing glasses covered with gold leaf, through which he could see the contour of bright clouds.